

Towards a 'New Deal' in Climate Policy!

Consumption-based approach for mitigation of GHG Emissions

Dabo Guan, University of Cambridge, UK

Christopher L. Weber, Carnegie Mellon University, Pittsburgh, PA

Glen P. Peters, Center for International Climate and Environmental Research (CICERO), Norway

Jan Minx, Stockholm Environment Institute, York, UK & Berlin, Germany

Klaus Hubacek, University of Leeds, UK

Overview

- Consumption-based approach
- On different spatial scales
 - International (trade)
 - National (US, China)
 - Regional (examples from the UK)
 - Local (housing project in Vienna, Austria)
- Summary

Today's production is based on global supply chains

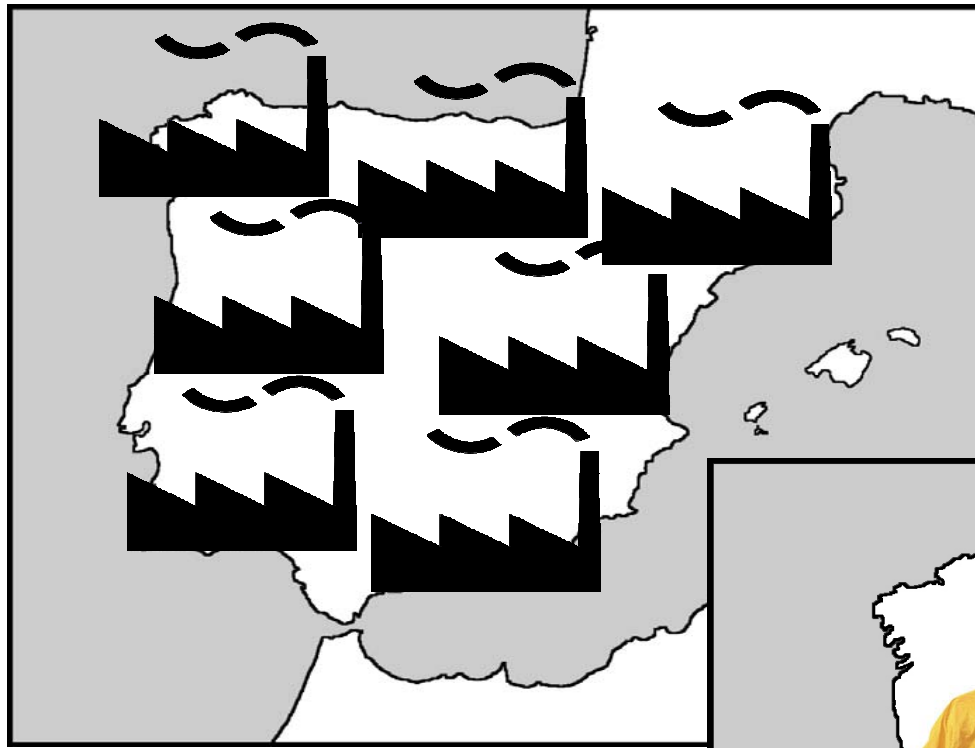
Division of labor "Sonicare Elite 7000" production and supply locations



What are consumption-based emissions?



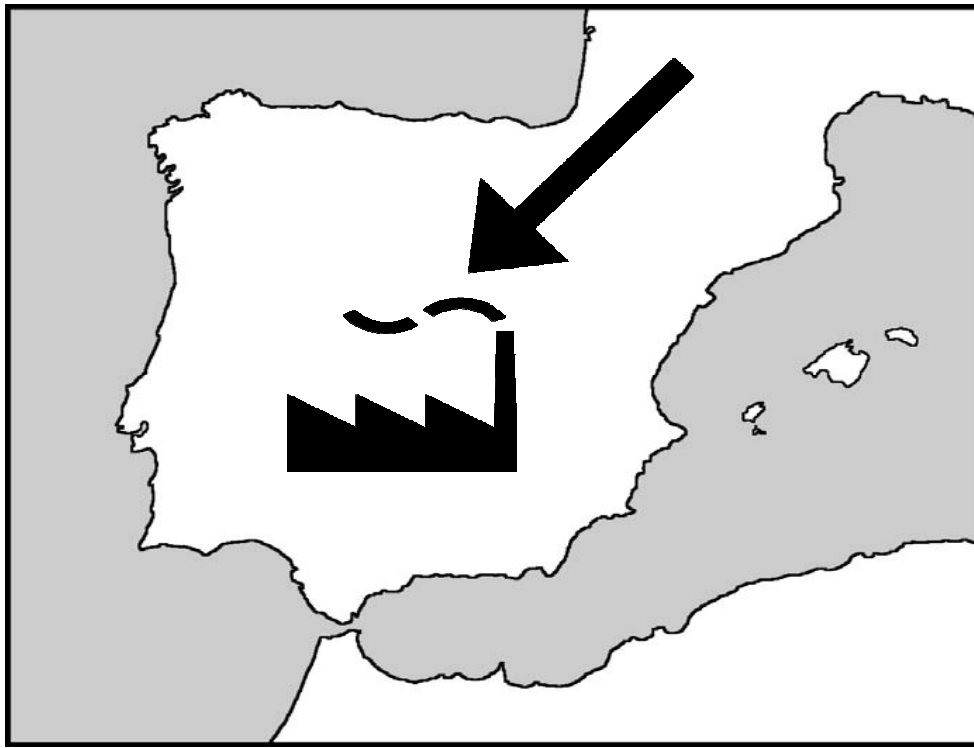
(Carbon Trust, 2006)



Similar to calculating emissions by all factories in a given territory

we could also calculate emissions by all products and services consumed in that territory

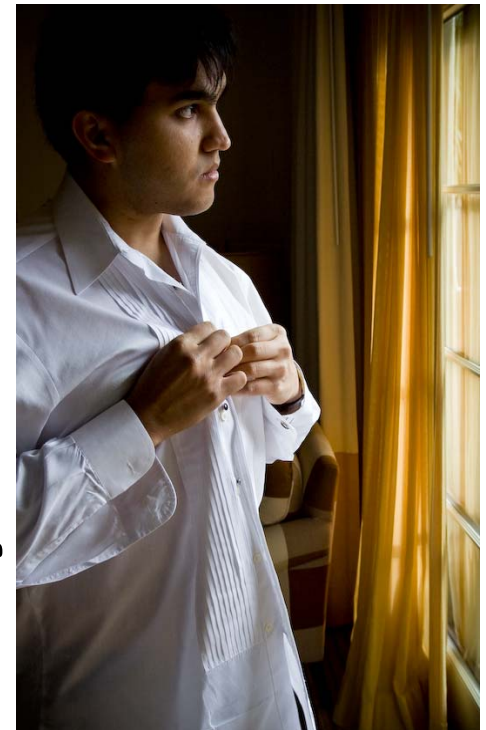




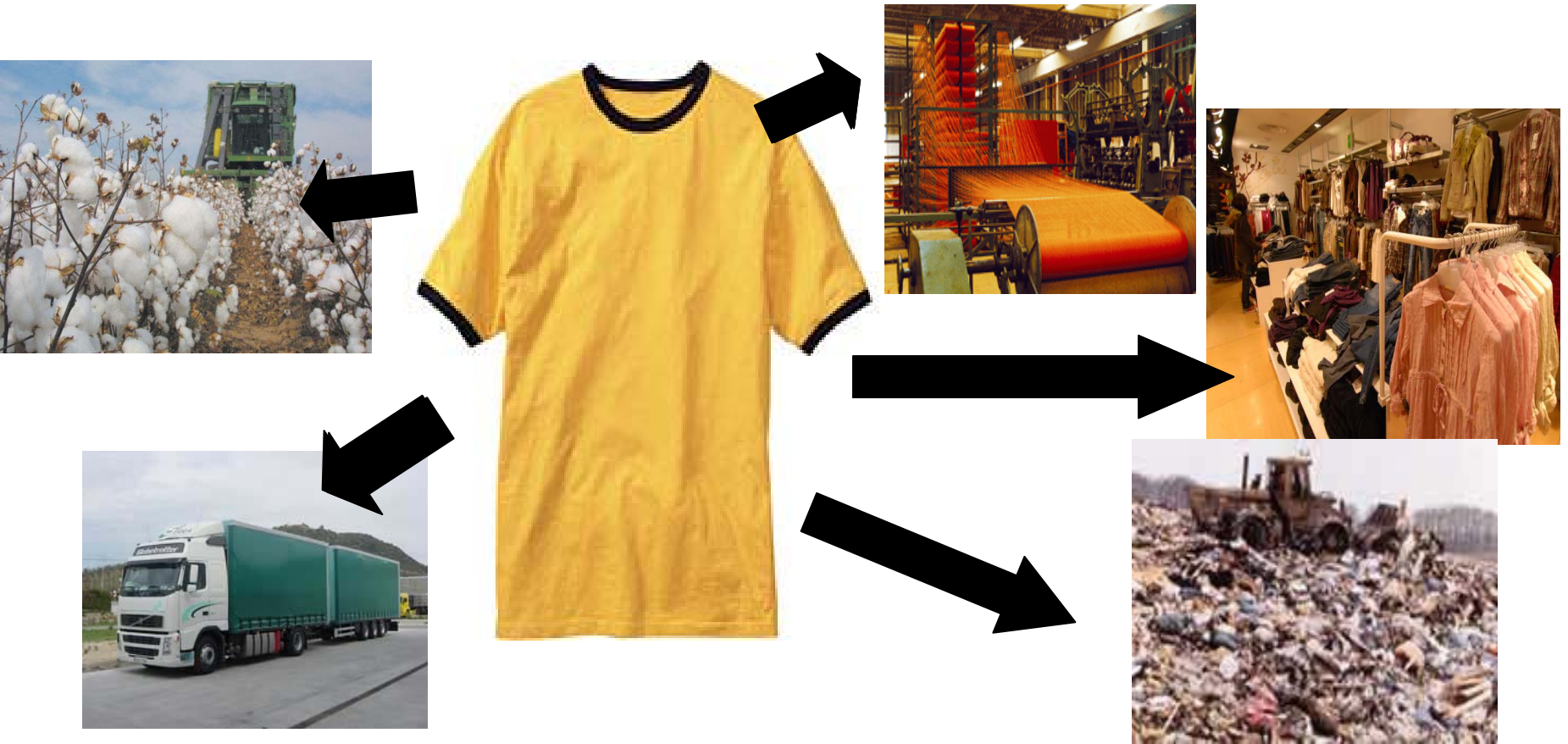
in the first case, we
will know **WHERE**
emissions occur

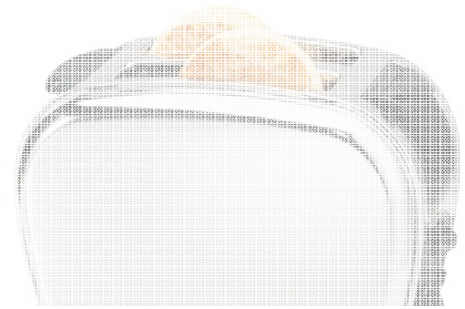
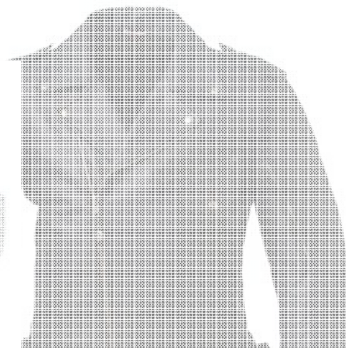
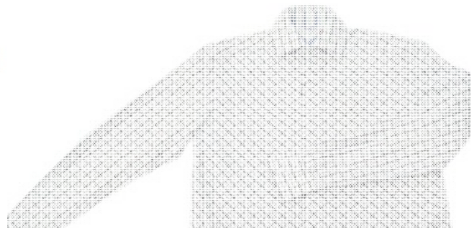
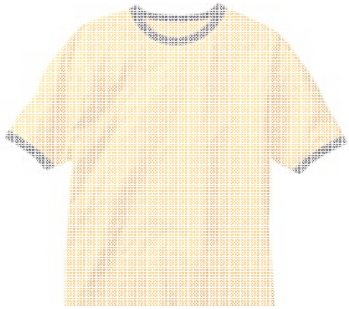


in the second
case, we will
know **WHY**
emissions occur



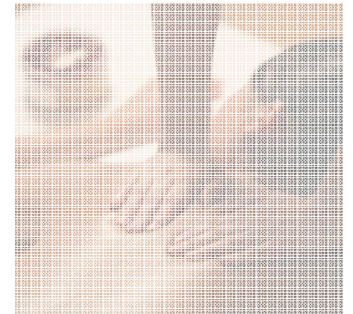
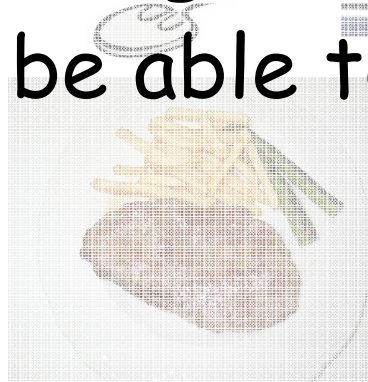
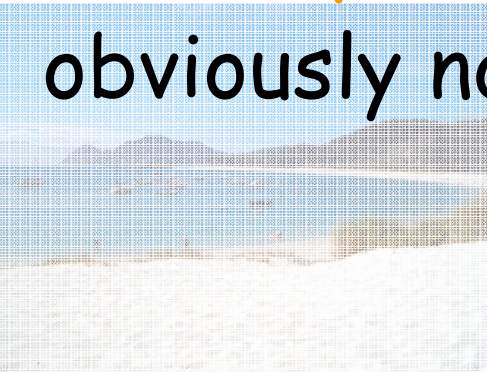
From cradle to the grave using Life-Cycle Analysis (LCA)





There are millions of products, each one is different from the other!

If we want to calculate emissions from **all consumption** of a given territory, we will obviously not be able to do that with LCA



"TOP DOWN" AND "BOTTOM-UP" APPROACH CONSUMPTION EMISSIONS (CARBON FOOTPRINT)

"TOP DOWN"

Input-Output Analysis



Carbon footprint of countries



Regional carbon footprint

Local carbon footprint

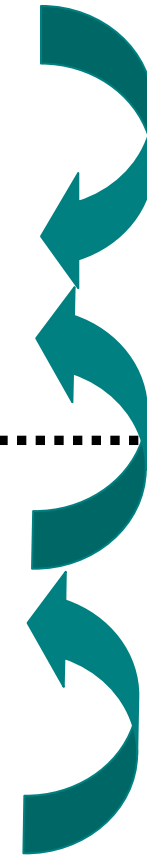


Carbon footprint of companies and organizations

Citizen carbon footprint



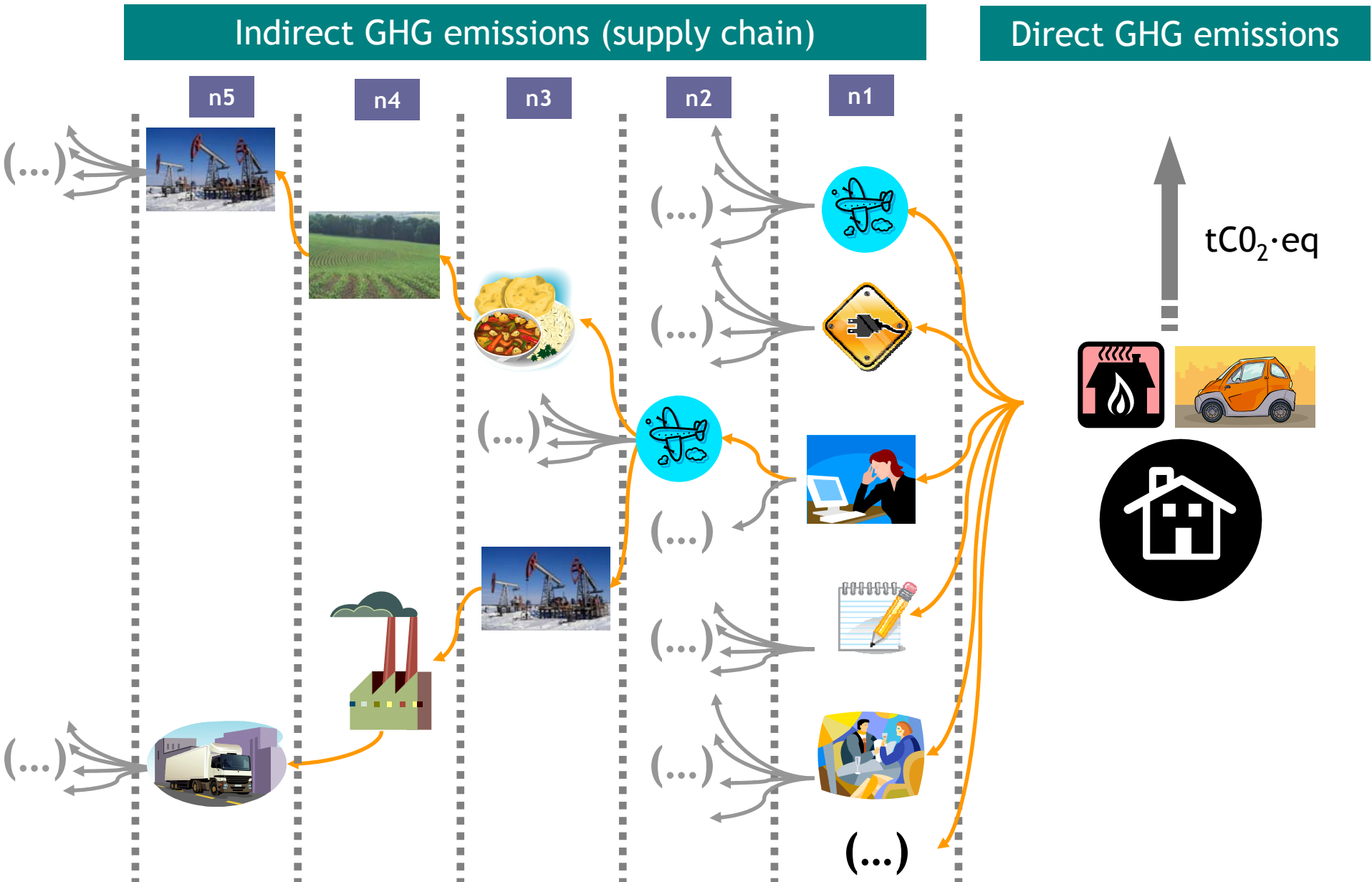
Carbon footprint of products and activities



"BOTTOM-UP"

LCA

What are direct and indirect emissions of a household?



CALCULATING CONSUMPTION EMISSIONS

MATRIZ INPUT-OUTPUT					
Unidad: millones €					
		Agricultura, ganadería y caza	Selvicultura	Pesca y acuicultura	Extracción y aglomeración de antracita, hulla, lignito y
		TSIO-01	TSIO-02	TSIO-03	TSIO-04
Productos de la agricultura, ganadería y caza	TSIO-01	2751,1	2,1	9,4	0
Productos de la selvicultura, de la explotación forestal y servicios afines	TSIO-02	18,4	0,5	0	0
Pescado y otros productos de la pesca; servicios relacionados con la pesca	TSIO-03	0	0	0	0
Antracita, hulla, lignito y turba	TSIO-04	0,5	0	0,2	0,2
Petróleo crudo ; Gas natural; Servicios relacionados con la extracción de petróleo	TSIO-05	0	0	0	0

Input-Output Tables
show how

- the sectors of an economy are interrelated (in \$)
- an economic activity *demand*s, in its production process, *inputs* from other economic activities
- an increase in final demand of a good or service produces an *indirect demand* of other goods and services that serve as intermediate inputs to producing that specific good

Production and consumption categories

Calculation of consumption emissions by production activities

Category of goods and services	SIOT code
Products of agriculture, hunting and related services	SIOT-01
Products of forestry, logging and related services	SIOT-02
Fish and other fishing products and related services	SIOT-03
Anthracite, coal, lignite and peat	SIOT-04
Crude petroleum and natural gas; services incidental to oil and gas extraction. Uranium and thorium ores	SIOT-05
Iron ores; non-ferrous metal ores, except uranium and thorium ores	SIOT-06
Non-metallic and non-energy ores	SIOT-07

(...)

Non-market education services	SIOT-65
Non-market healthcare and veterinary services; social services	SIOT-66
Non-market public sanitation services	SIOT-67
Services provided by trade unions; services provided by other types of associations	SIOT-68
Non-market recreational, cultural and sporting services	SIOT-69
Private households with employed persons	SIOT-70
Financial mediation services indirectly measured (FISIM)	SIOT-71

Consumption categories (COICOP group)

Food (*COICOP 1, 2*)

Clothing and footwear (*COICOP 3*)

Household energy (*COICOP 45*)

Housing, furnishings and household goods (*COICOP 4, 5*)

Health (*COICOP 6*)

Transport (*COICOP 7*)

Communication (*COICOP 8*)

Recreation and culture (*COICOP 9*)

Education (*COICOP 10*)

Restaurants and hotels (*COICOP*

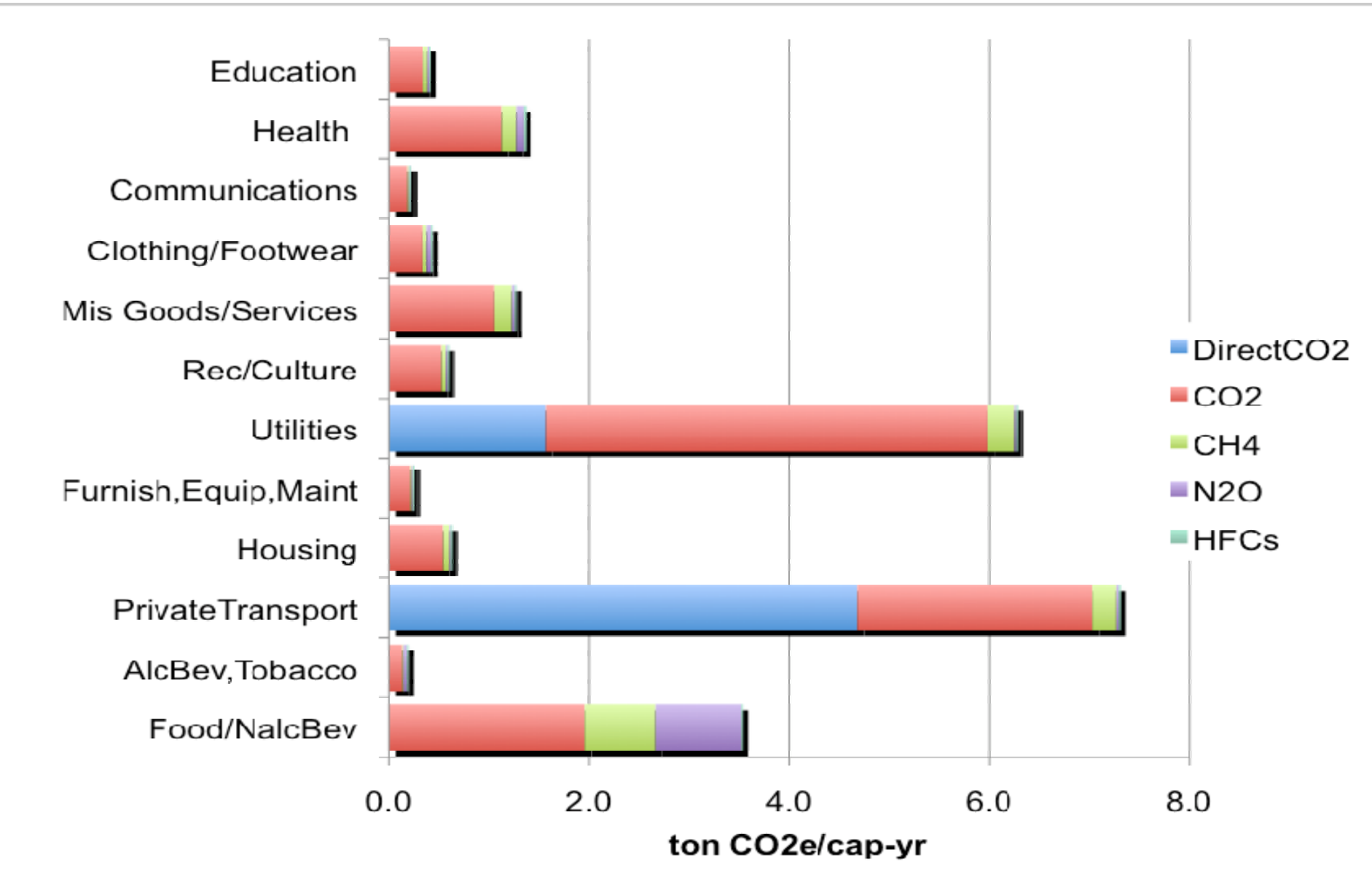
¹¹)
Miscellaneous goods and services
(*COICOP 12*)



Households

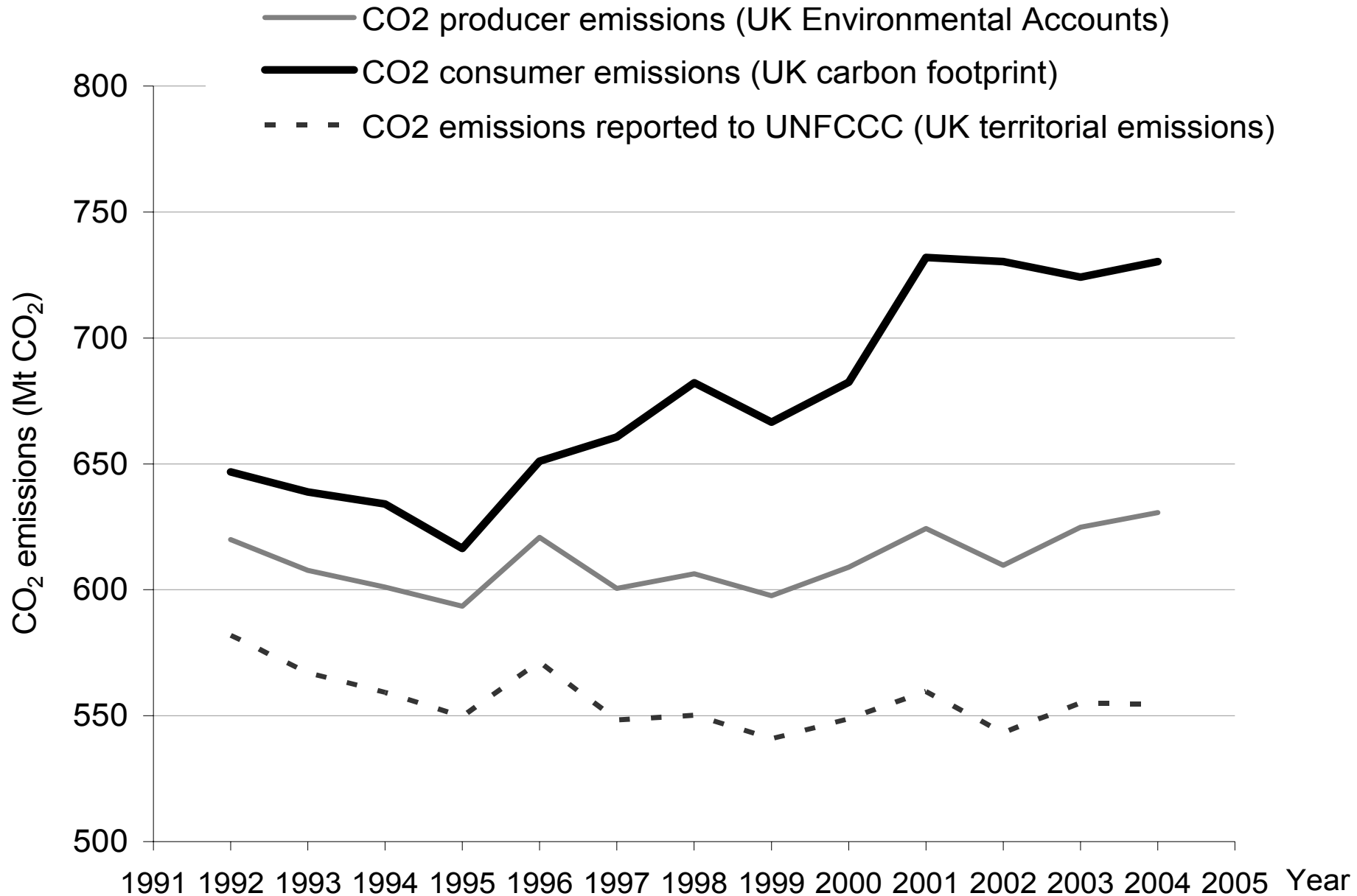
(Santacana, 2008)

What are **direct** and **indirect** emissions of a household?



(Weber & Matthews 2008 with newer data)

UK's CO₂ emissions



Summary - Methods

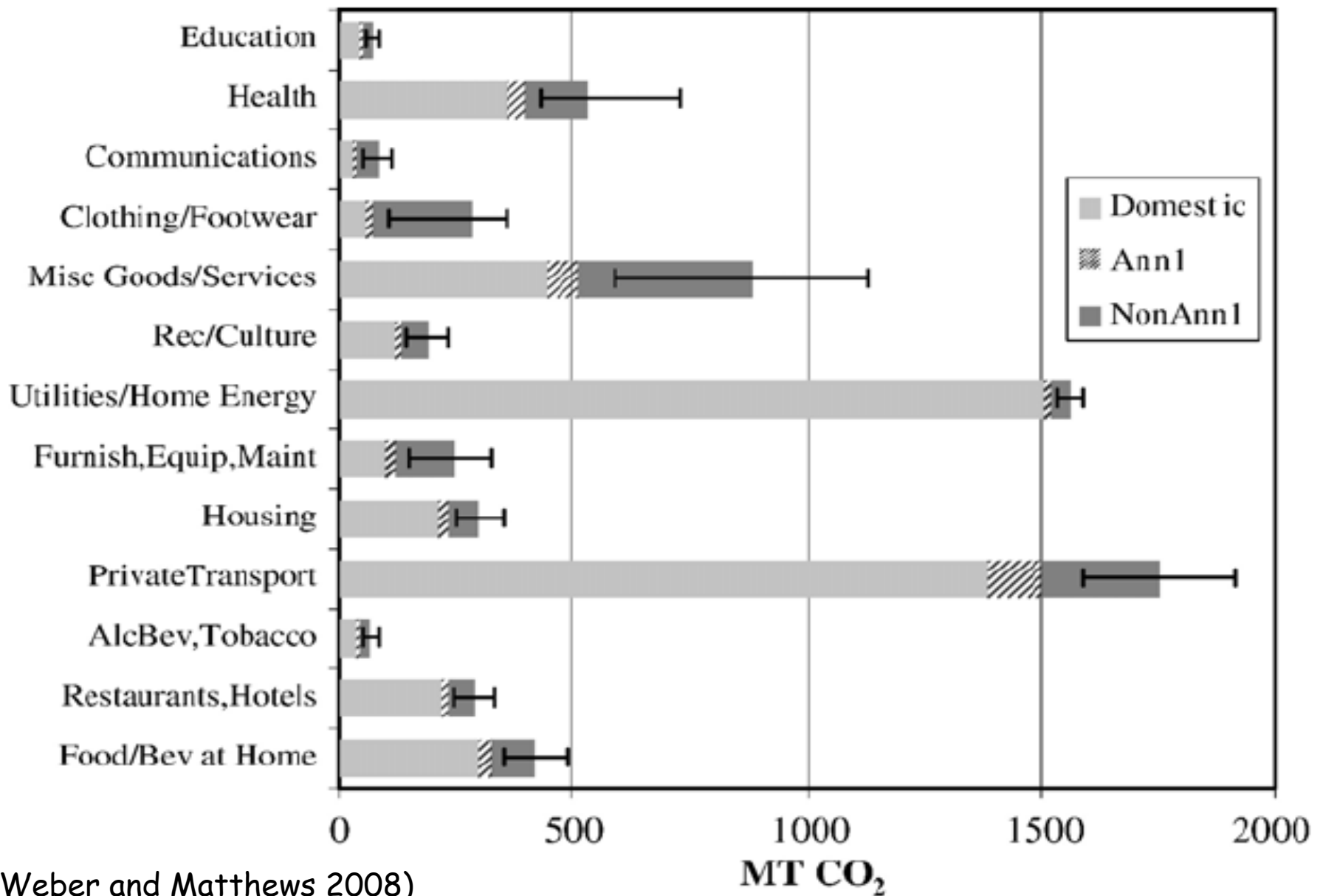
- Production versus consumption-based accounting approach
- Hybrid models (IO & LCA)
- Problems

Next: some applications

International trade

ITAL FLORIDA
TRIESTE

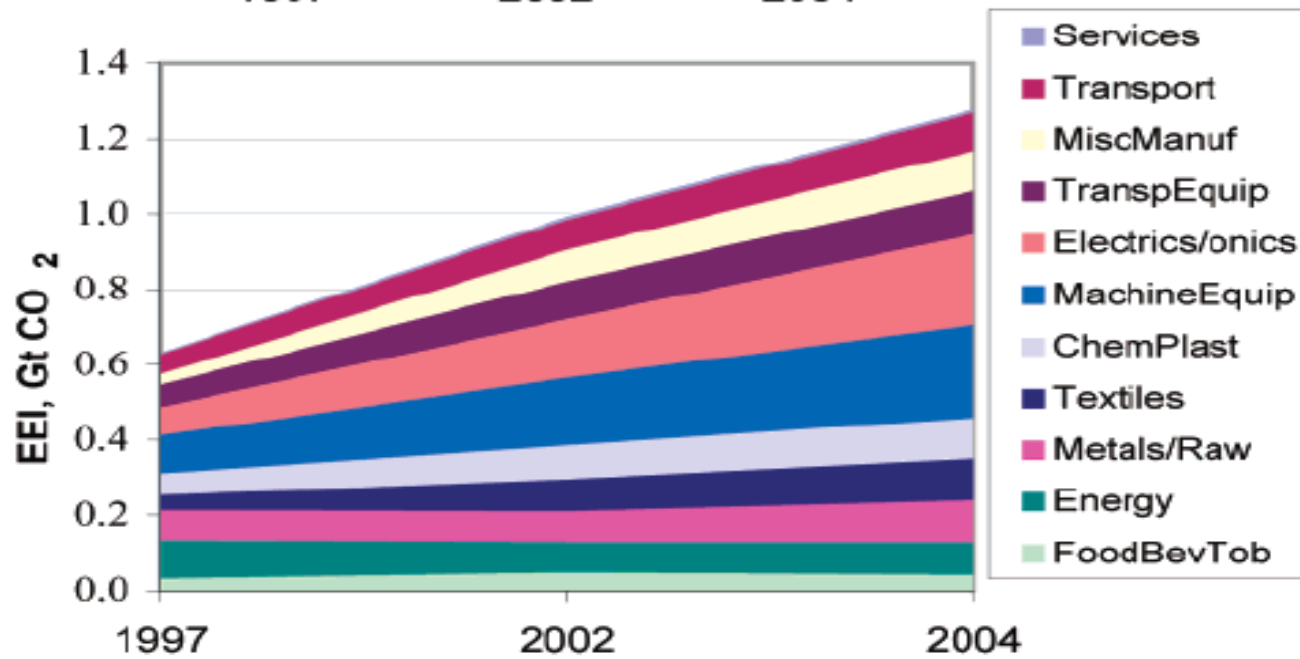
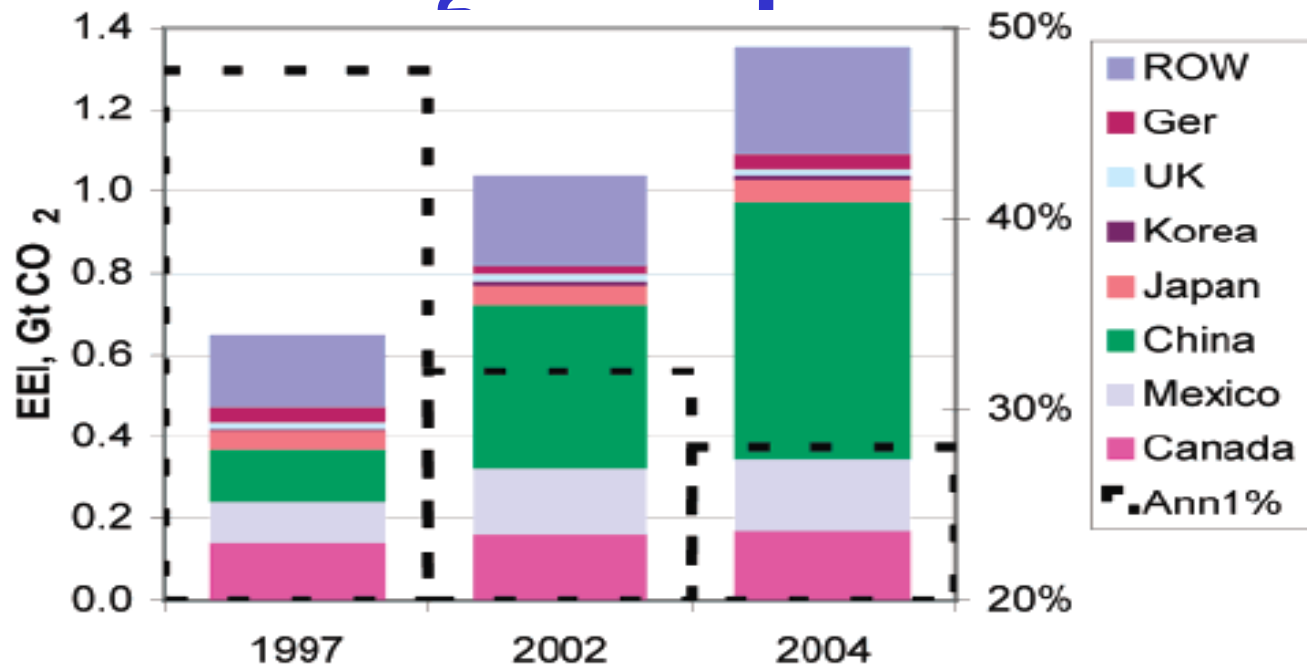
US household CO₂ and location of imports (2004)



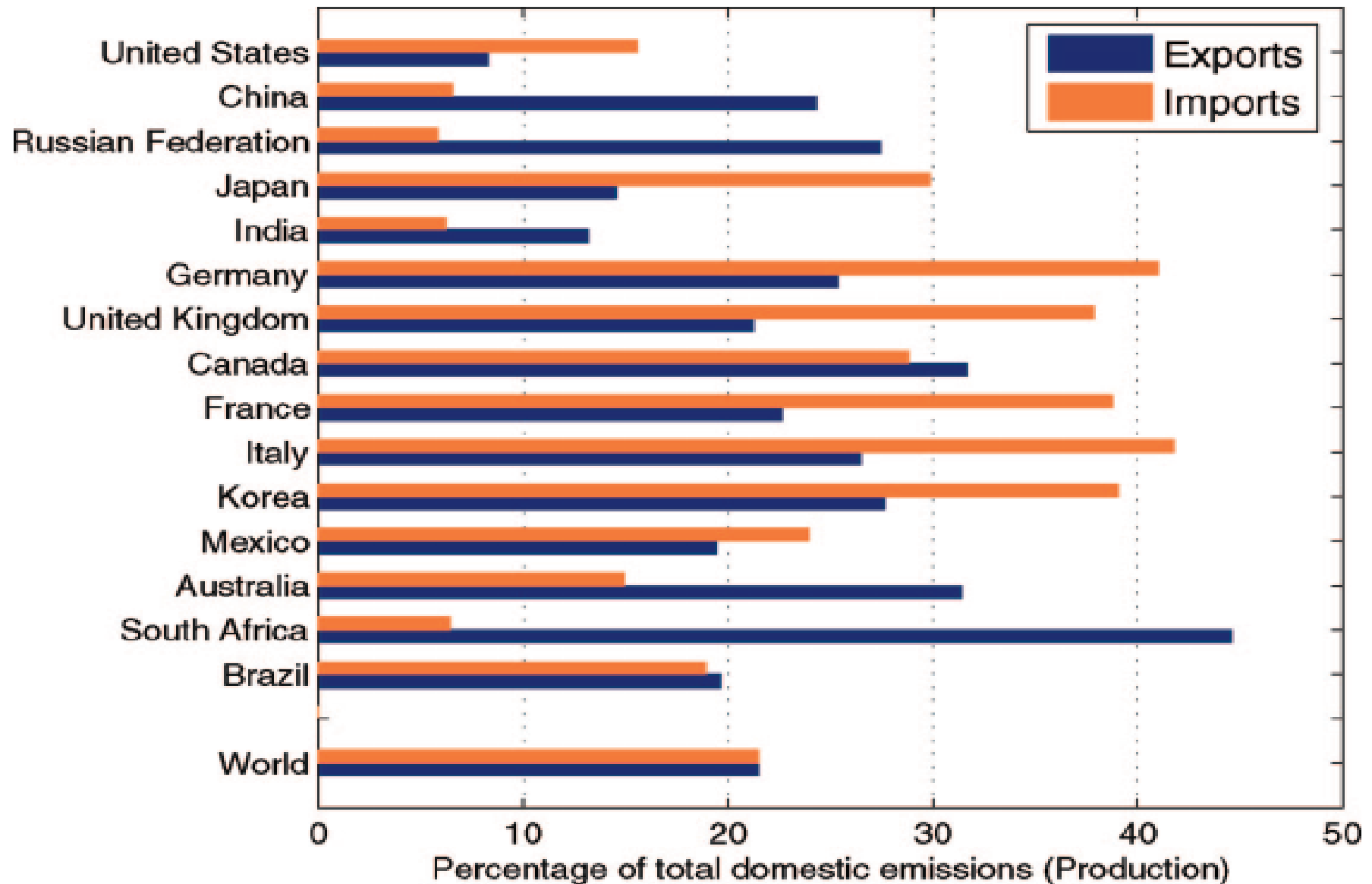
(Weber and Matthews 2008)

Embodied CO_2 in imports

(Weber and Matthews, 2008)

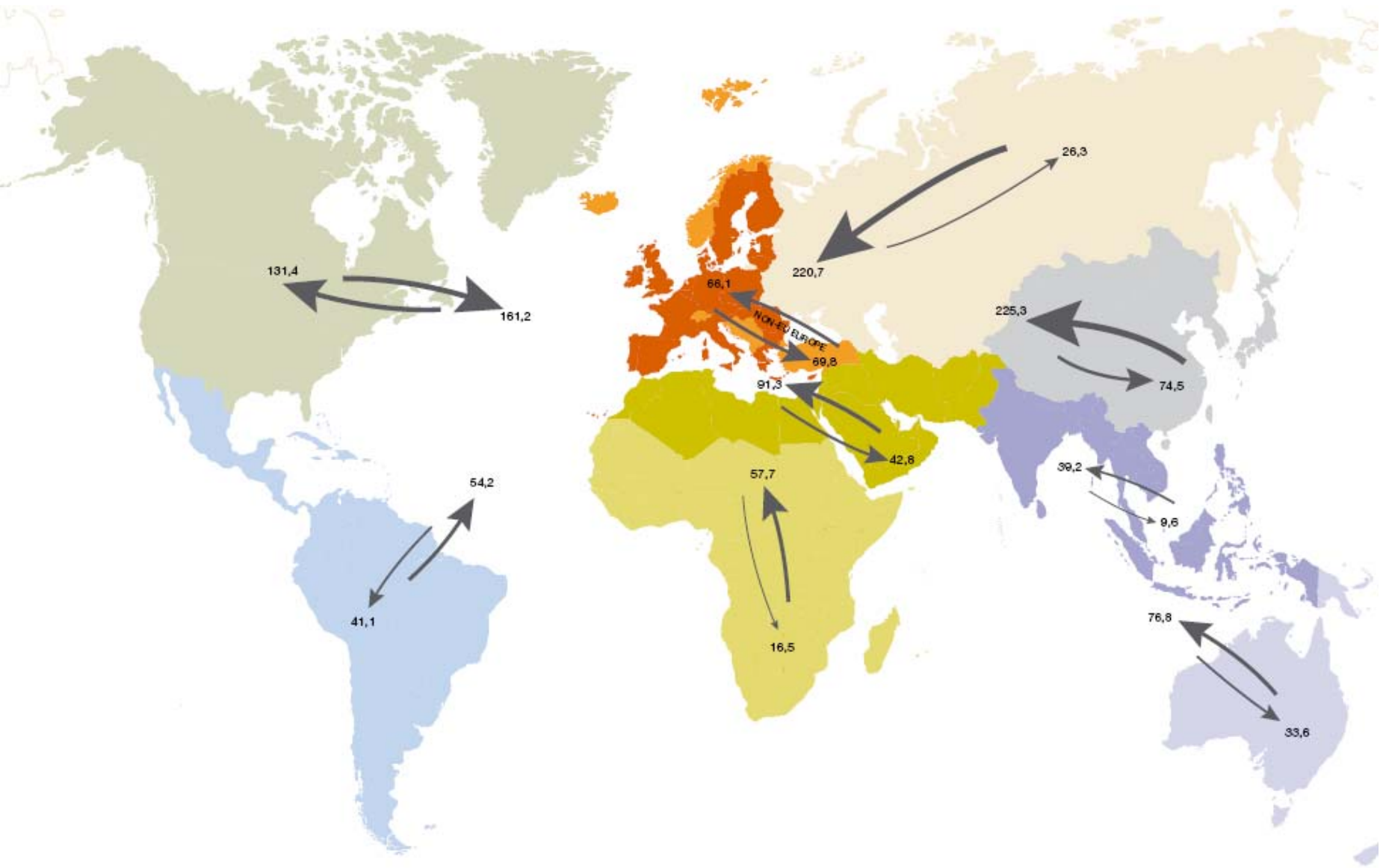


Embodied CO₂ in exports and imports (2001)



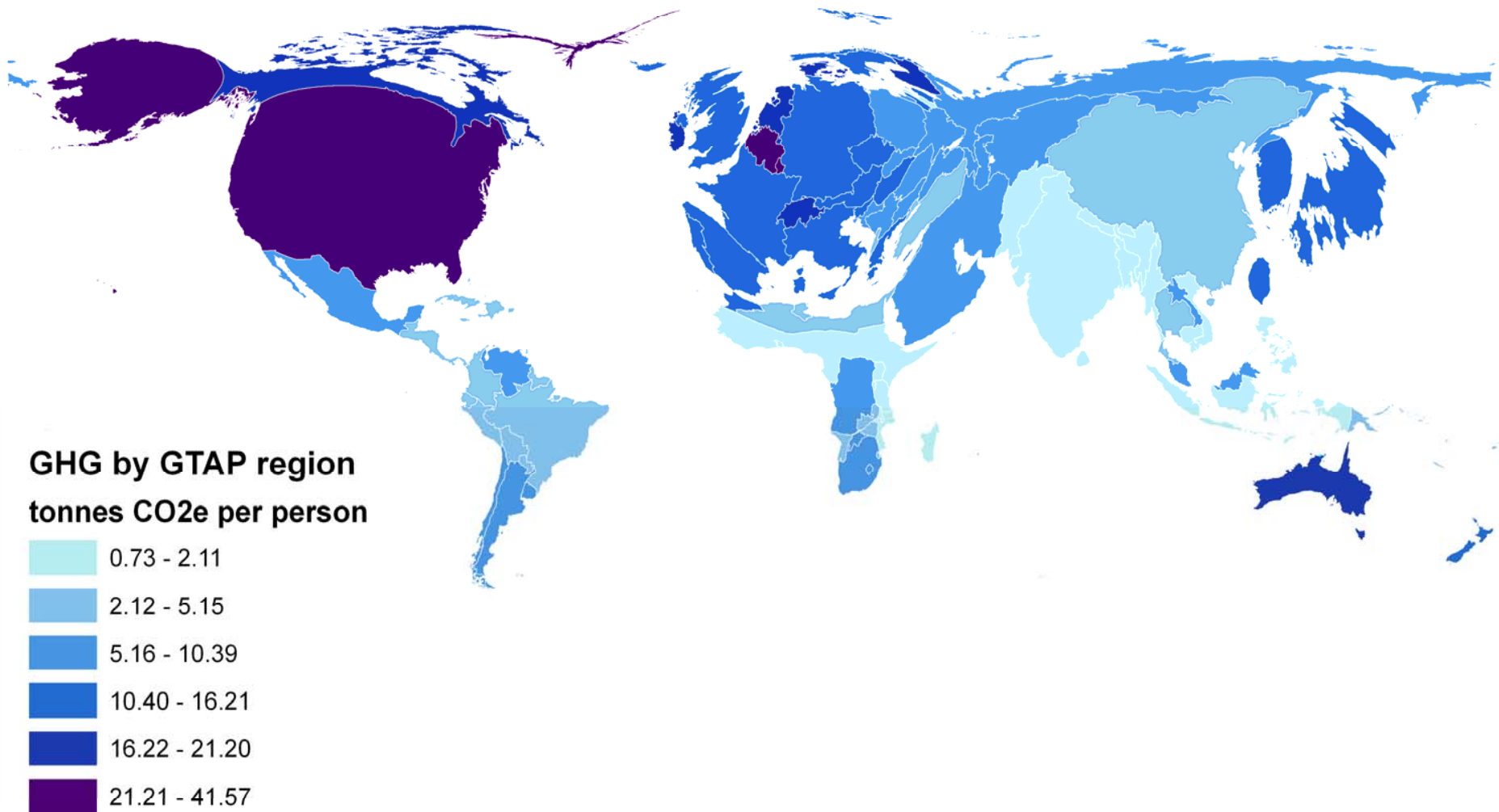
(Peters and Hertwich 2008)

EU CO2 Trade Balances

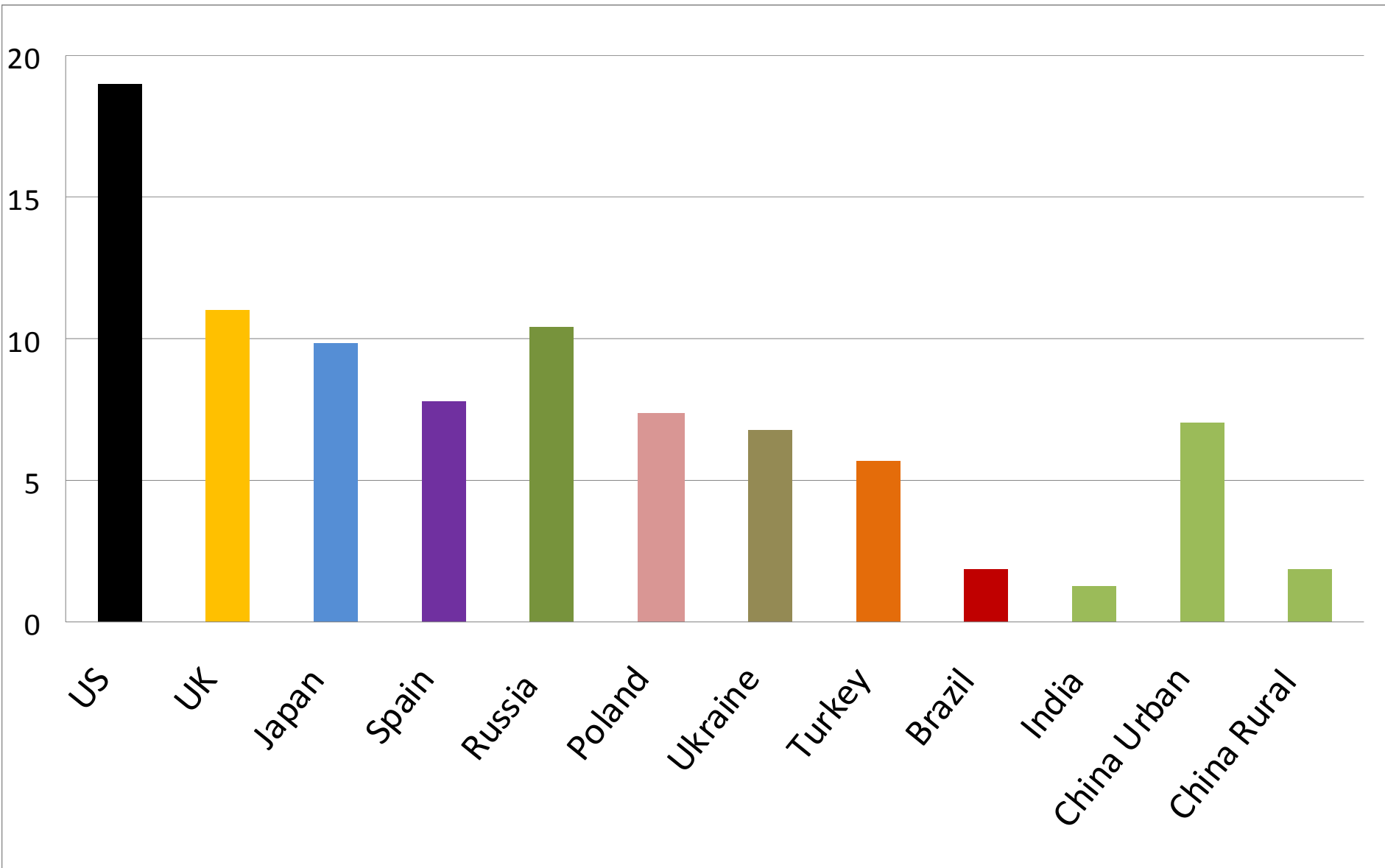


Source: Komerup Bang et al. (2008)

Cartogram morphed by total GHG emissions from consumption



Per capita Carbon Footprints



(Various sources)

Summary - Trade

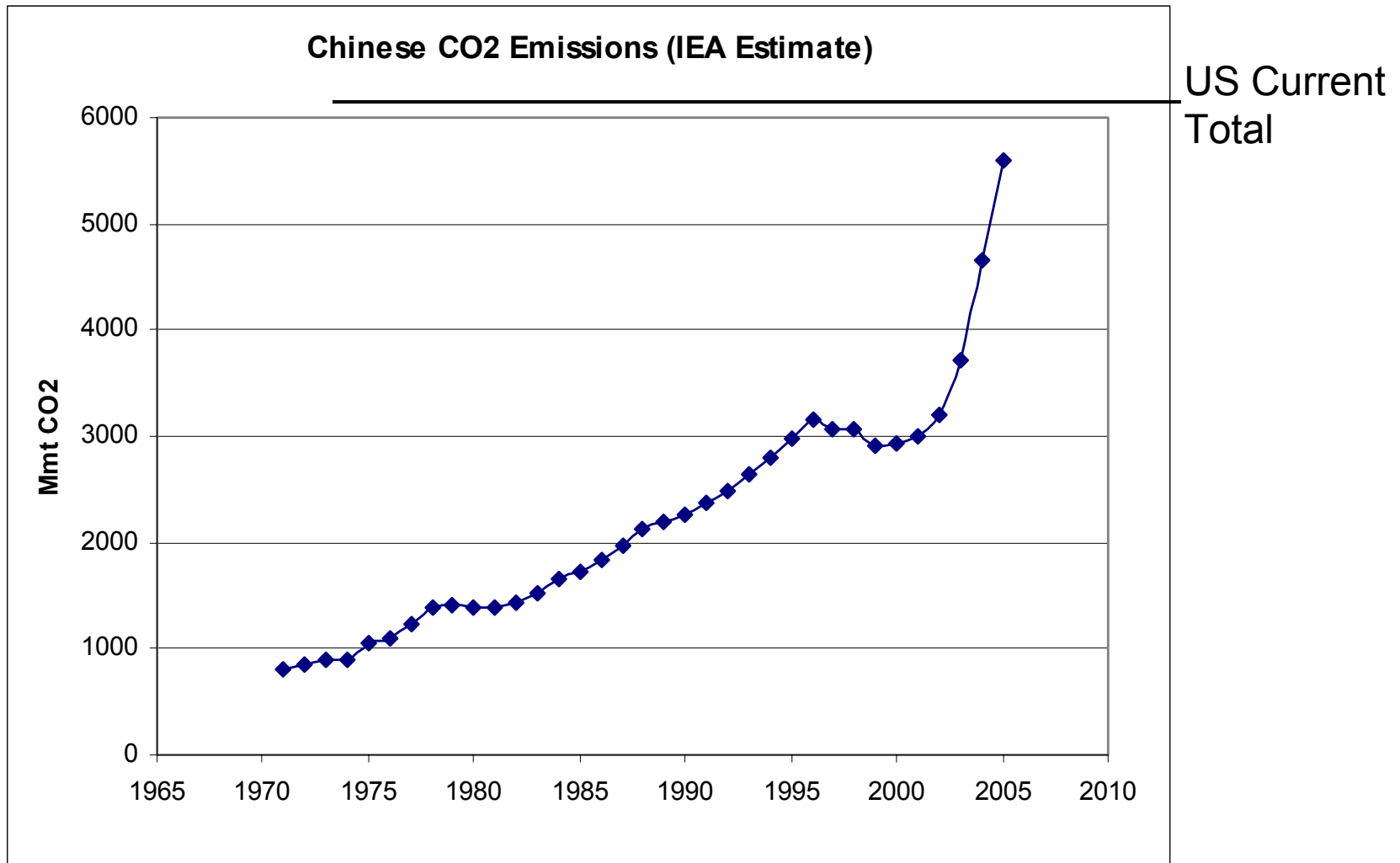
- Large inequalities internationally
- And within countries
- Consumption-based approach favours developing countries

Next: China

China

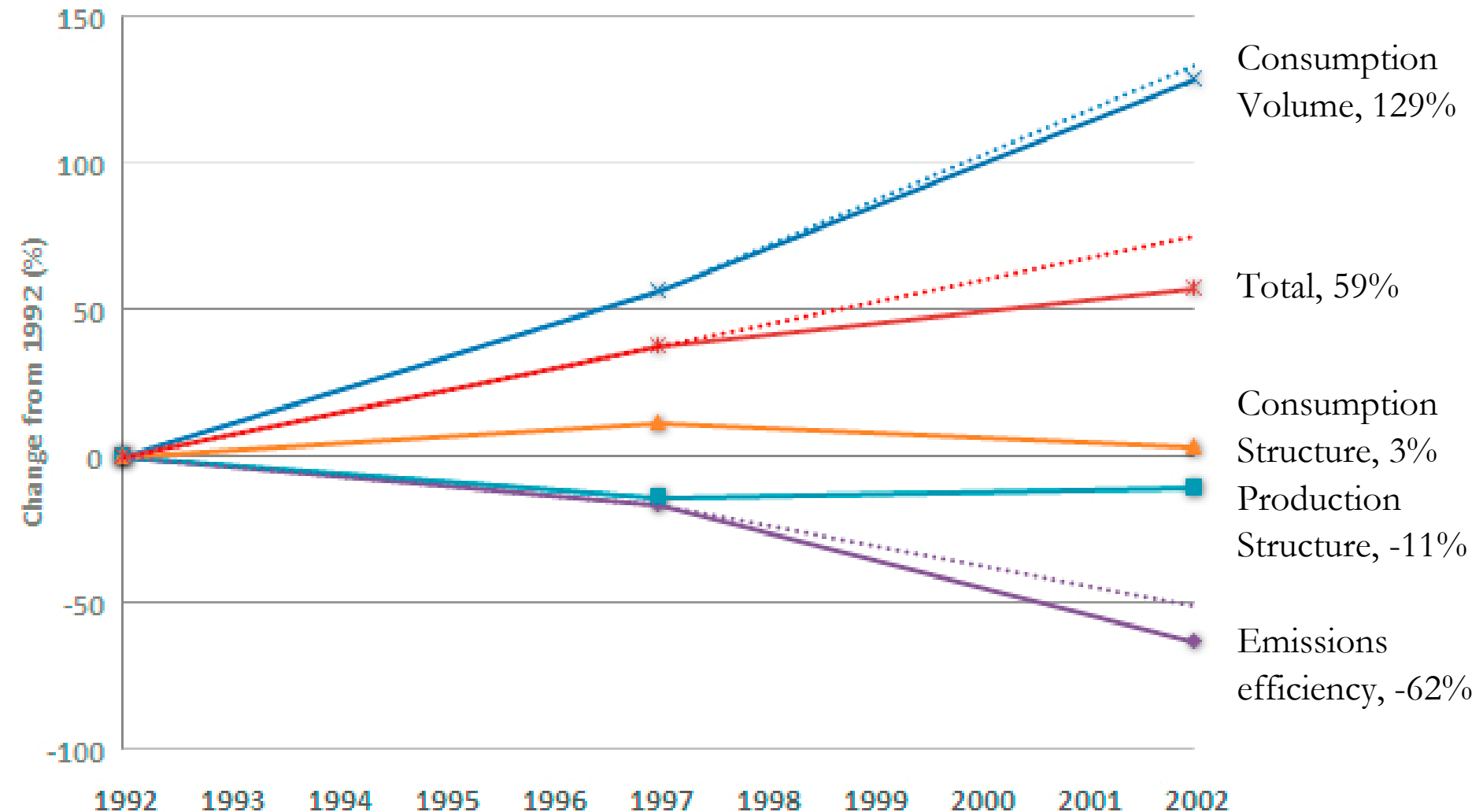


Motivation: China's CO₂ Emissions



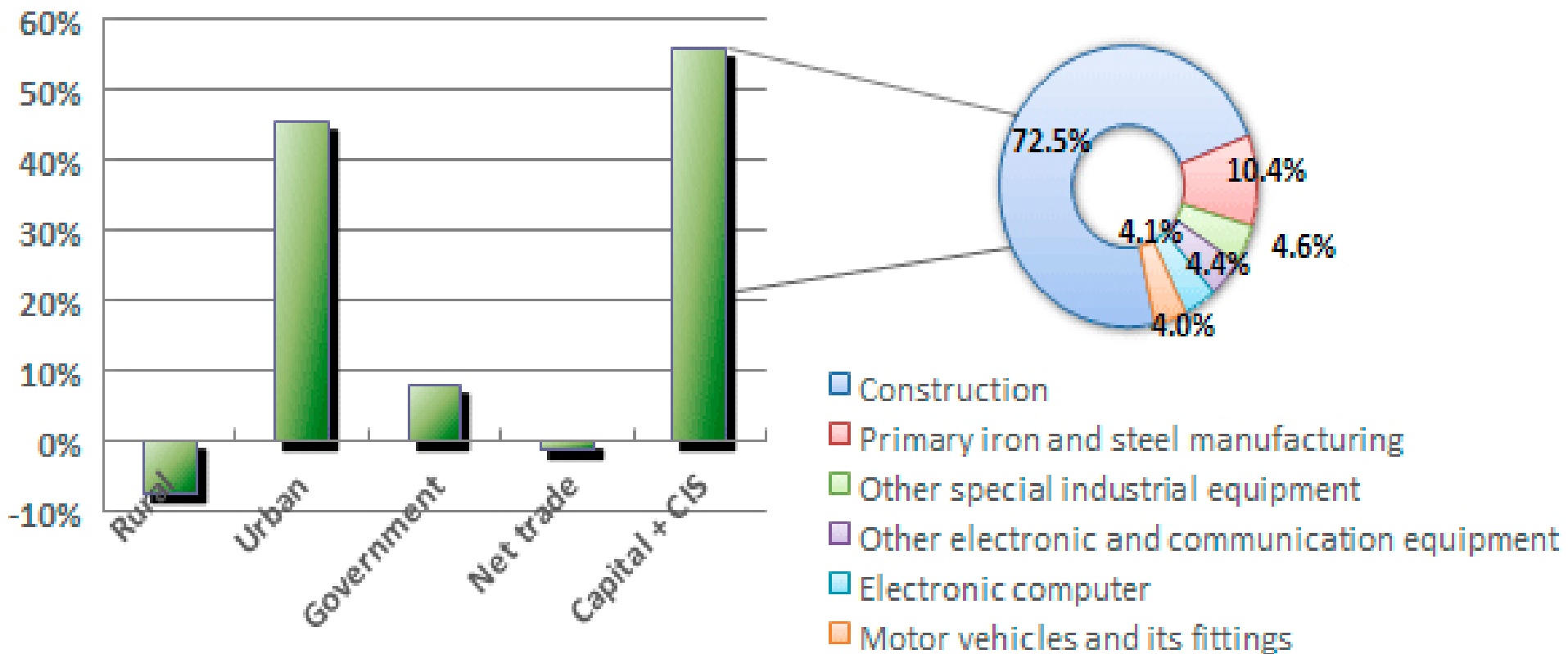
China: Structural Decomposition Analysis

- From 1992 to 2002, 59% increase in CO₂



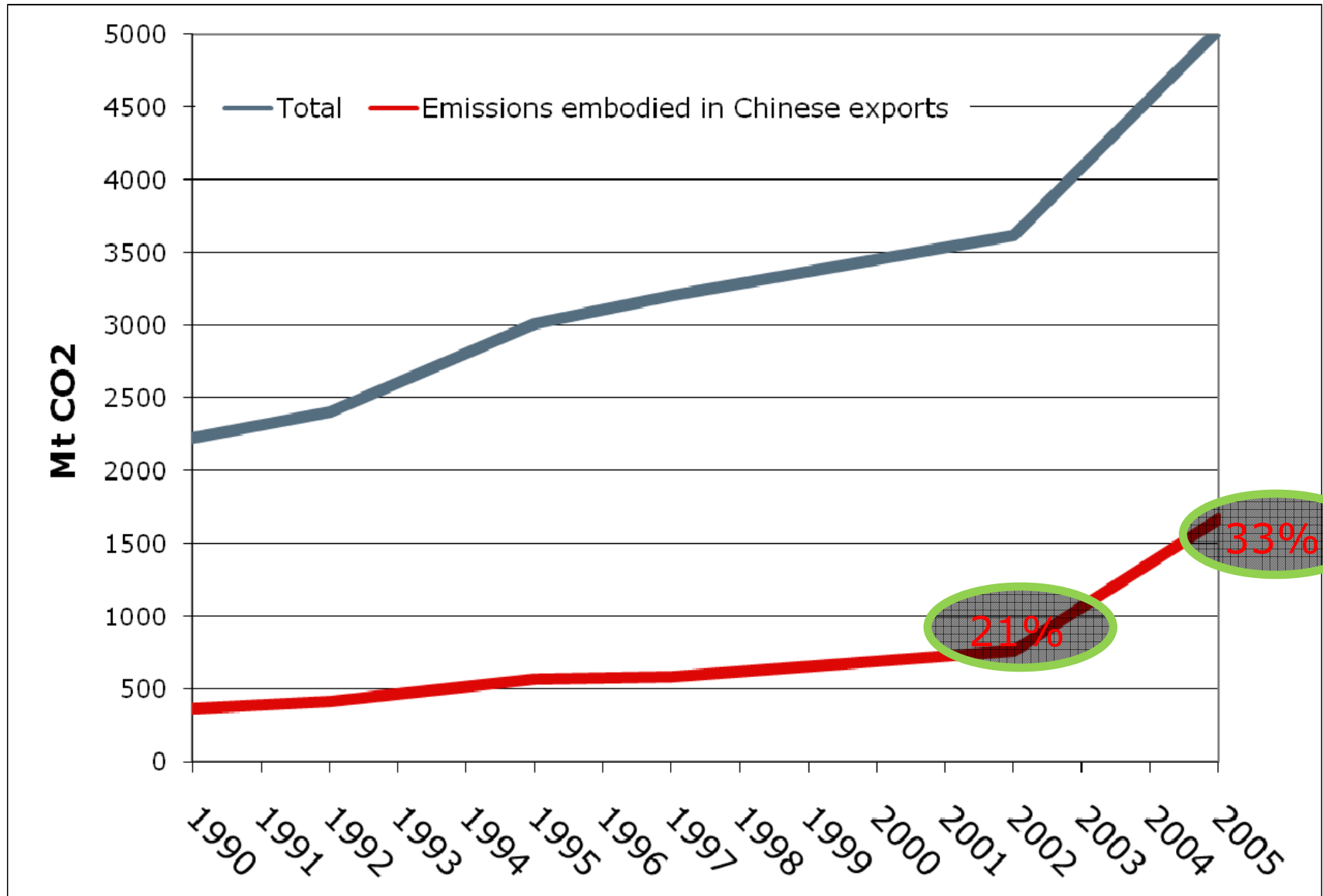
Drivers of change (1992-2002)

The contribution of the different final demands to changes in the SDA



China's exports

(Weber et al., 2008)



Destinations of China's exports

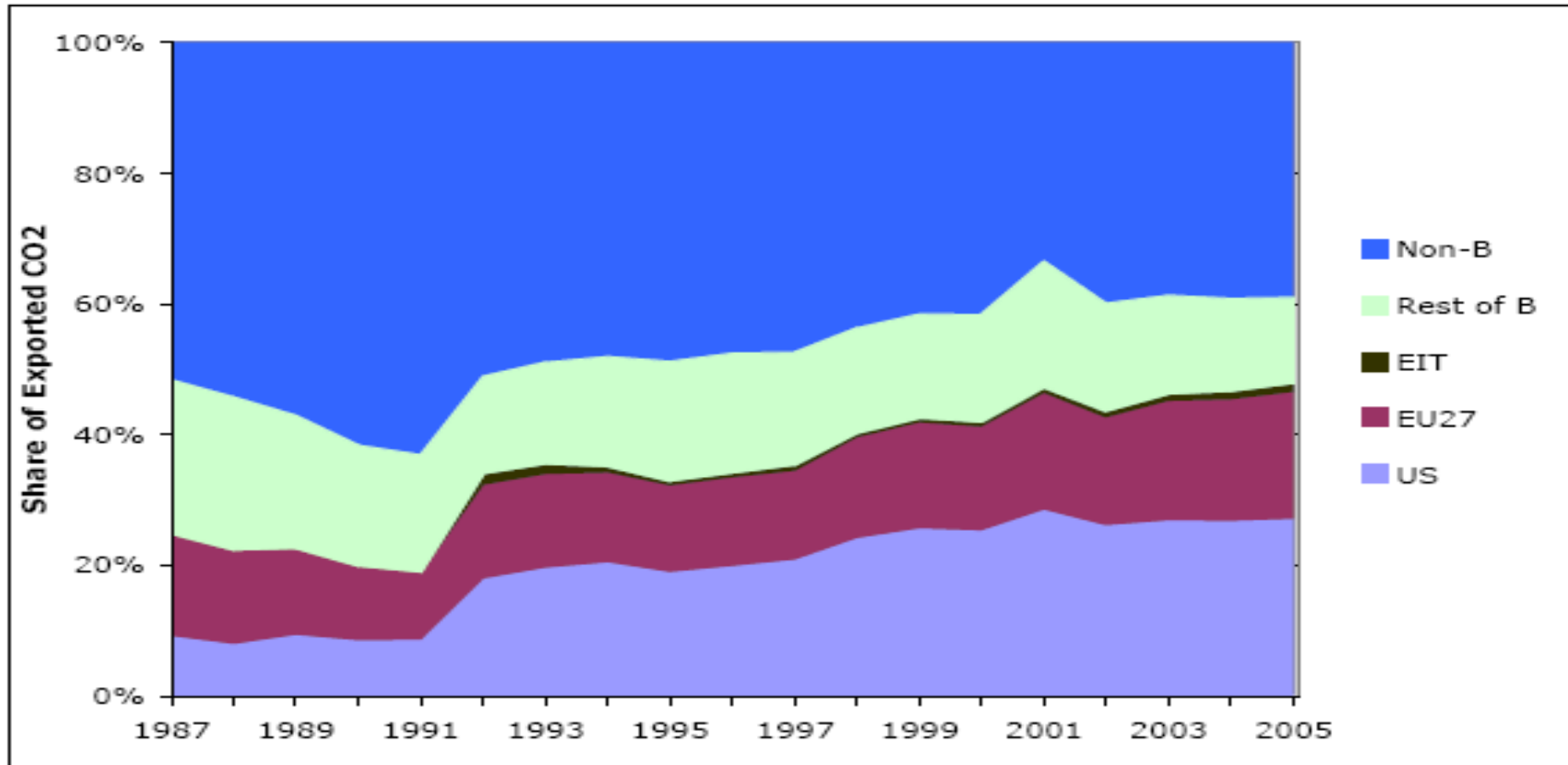
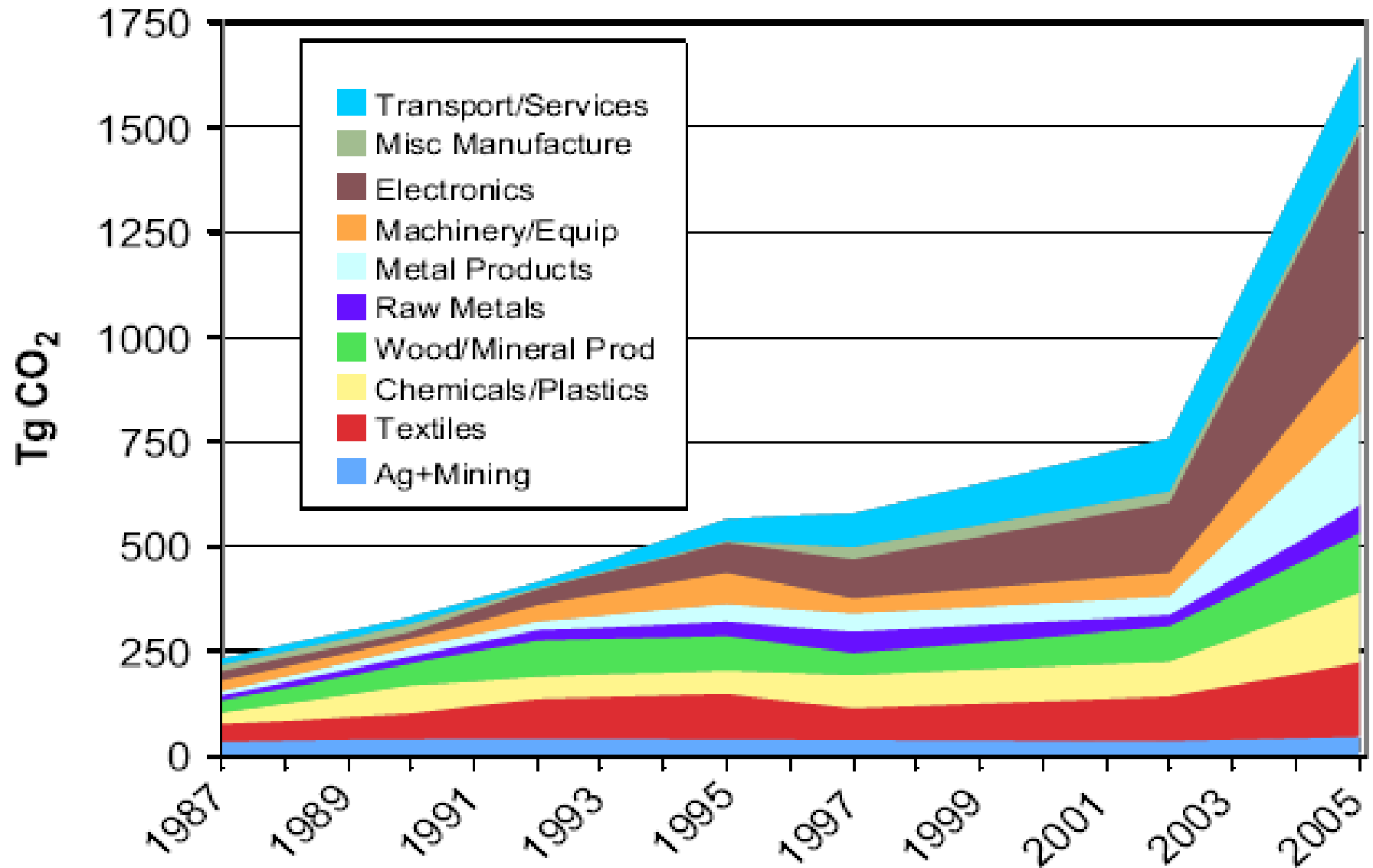


Figure 1: Region of destination for Chinese CO2 emissions embodied in exports by year. EU27 does not include any economies in transition (EIT), and "Rest of B" represents all remaining Annex B countries which do not fall into another group.

(Weber et al. 2008)

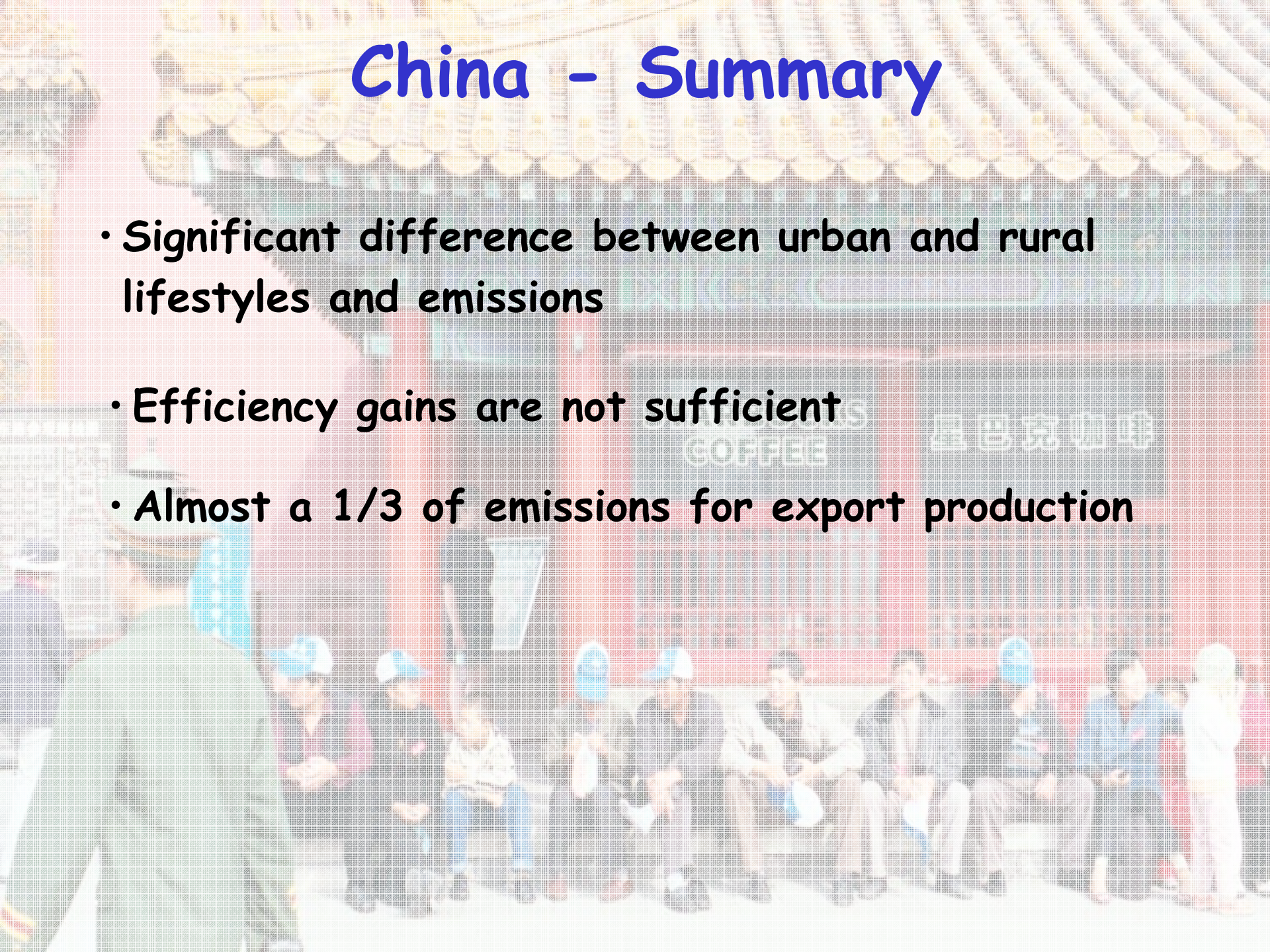
Chinese export emissions by commodity group



(Weber et al. 2008)

China - Summary

- Significant difference between urban and rural lifestyles and emissions
- Efficiency gains are not sufficient
- Almost a 1/3 of emissions for export production



UK

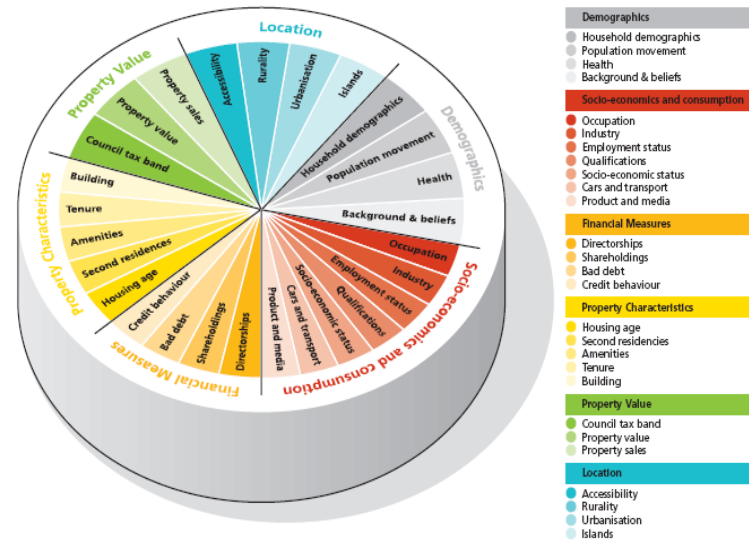
RULES BRITANNIA

MOSAIC: Using Geo-demographic Marketing Data

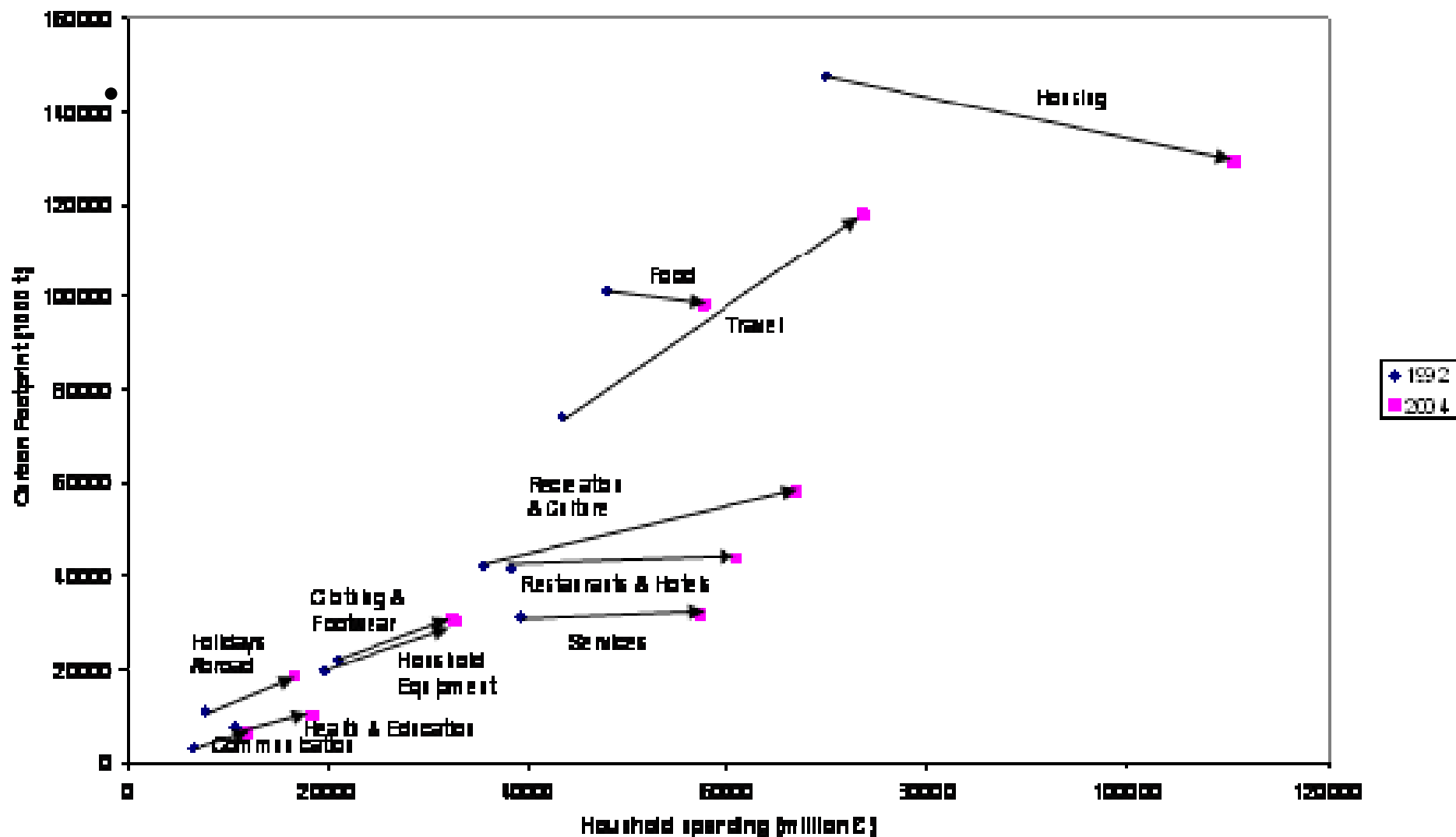


- Comprehensive post-code specific information on property, residents and their lifestyle
- 61 lifestyle groups
- over 400 variables

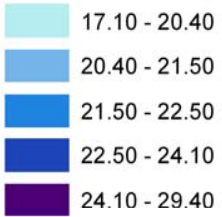
- Experian: world leading supplier of consumer segmentation
- MOSAIC UK: consumer classification



UK Final demand decomposition



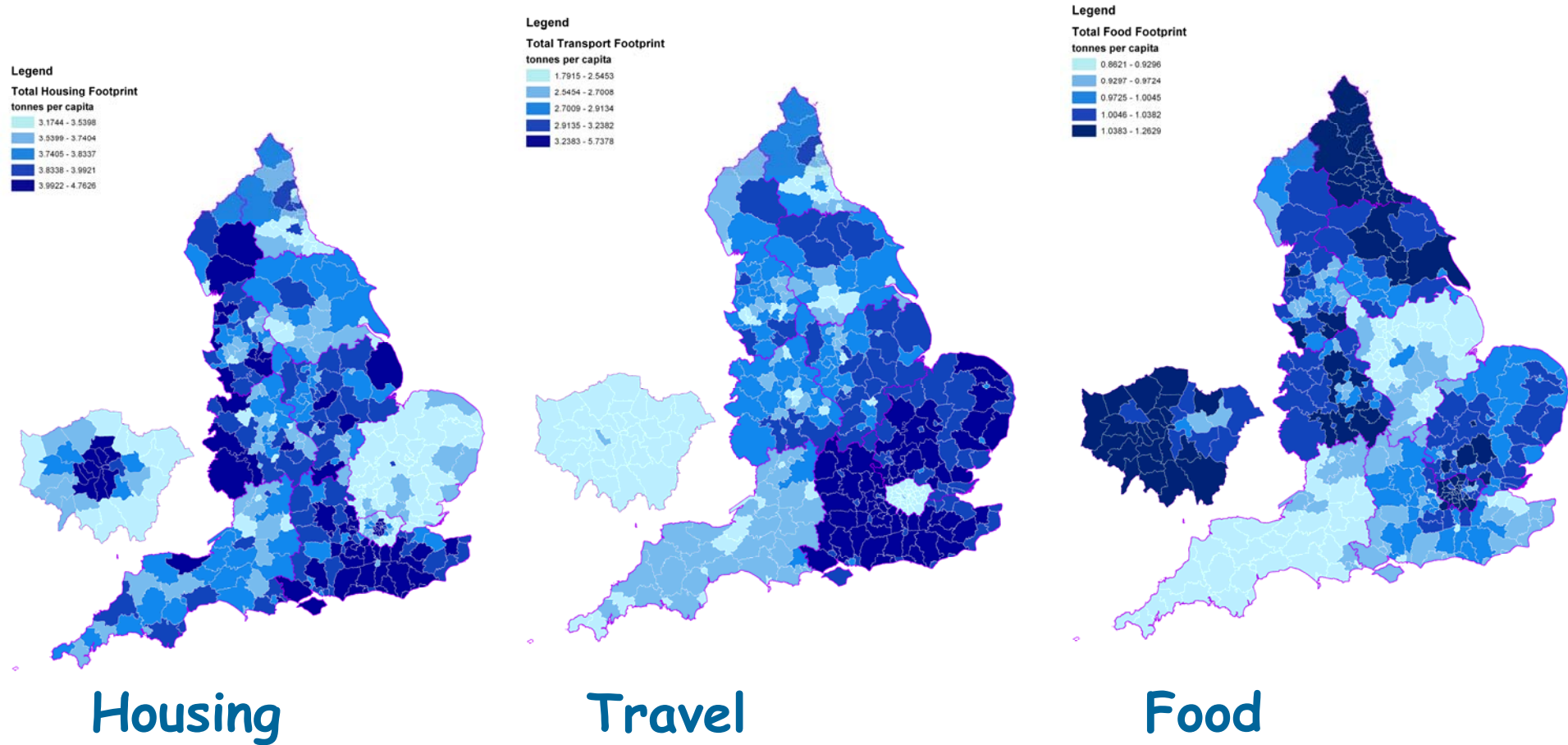
CO2 by Local Authority
tonnes of CO2 per household



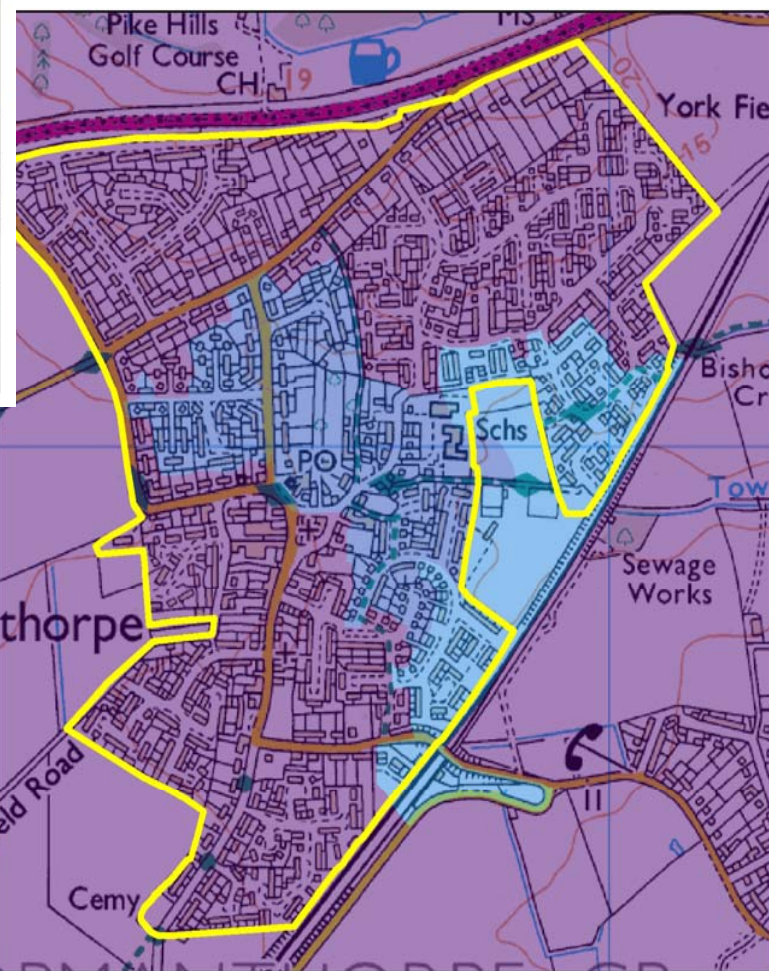
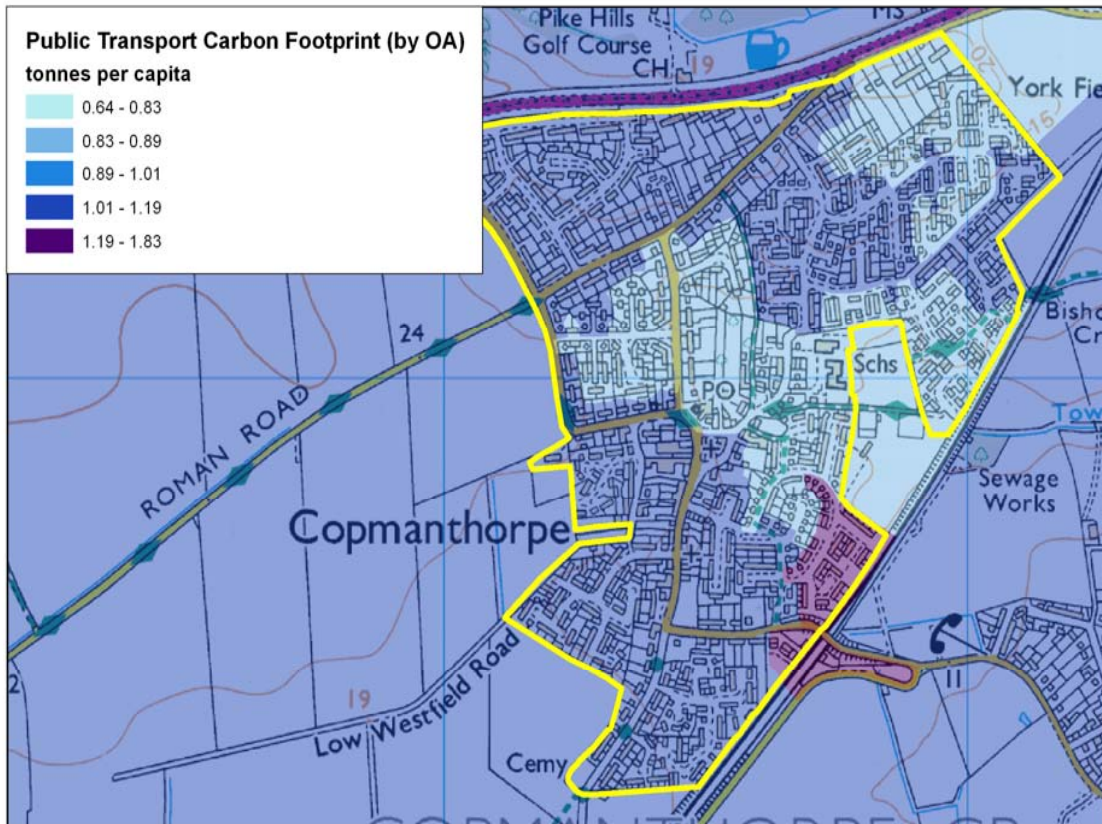
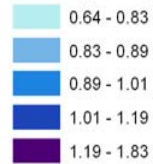
Average weekly household total income
pounds sterling



Specific carbon footprints



Public Transport Carbon Footprint (by OA)
tonnes per capita



Case Study



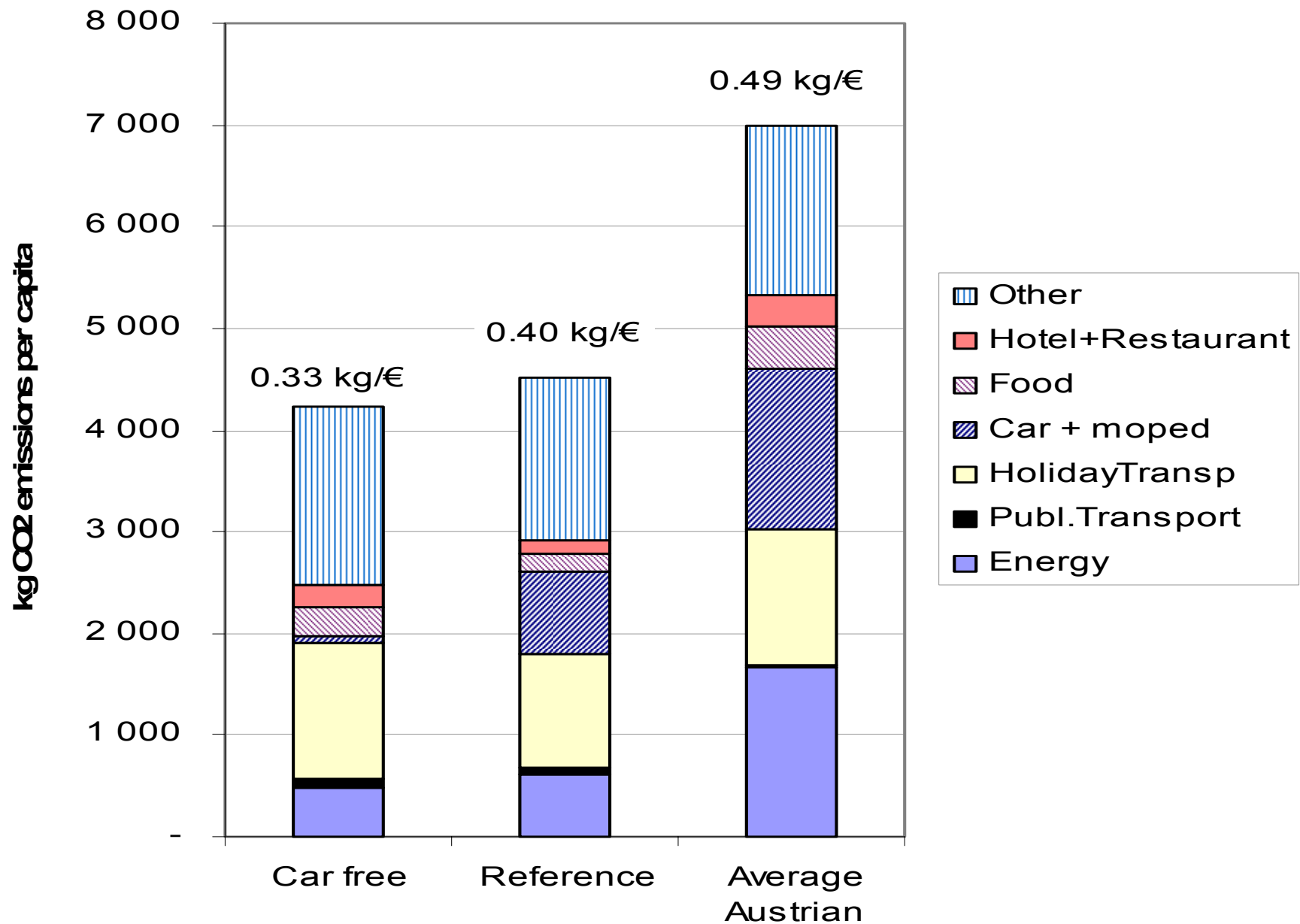
Car-Free City: Vienna, Austria



(Ornetzeder et al. 2007)



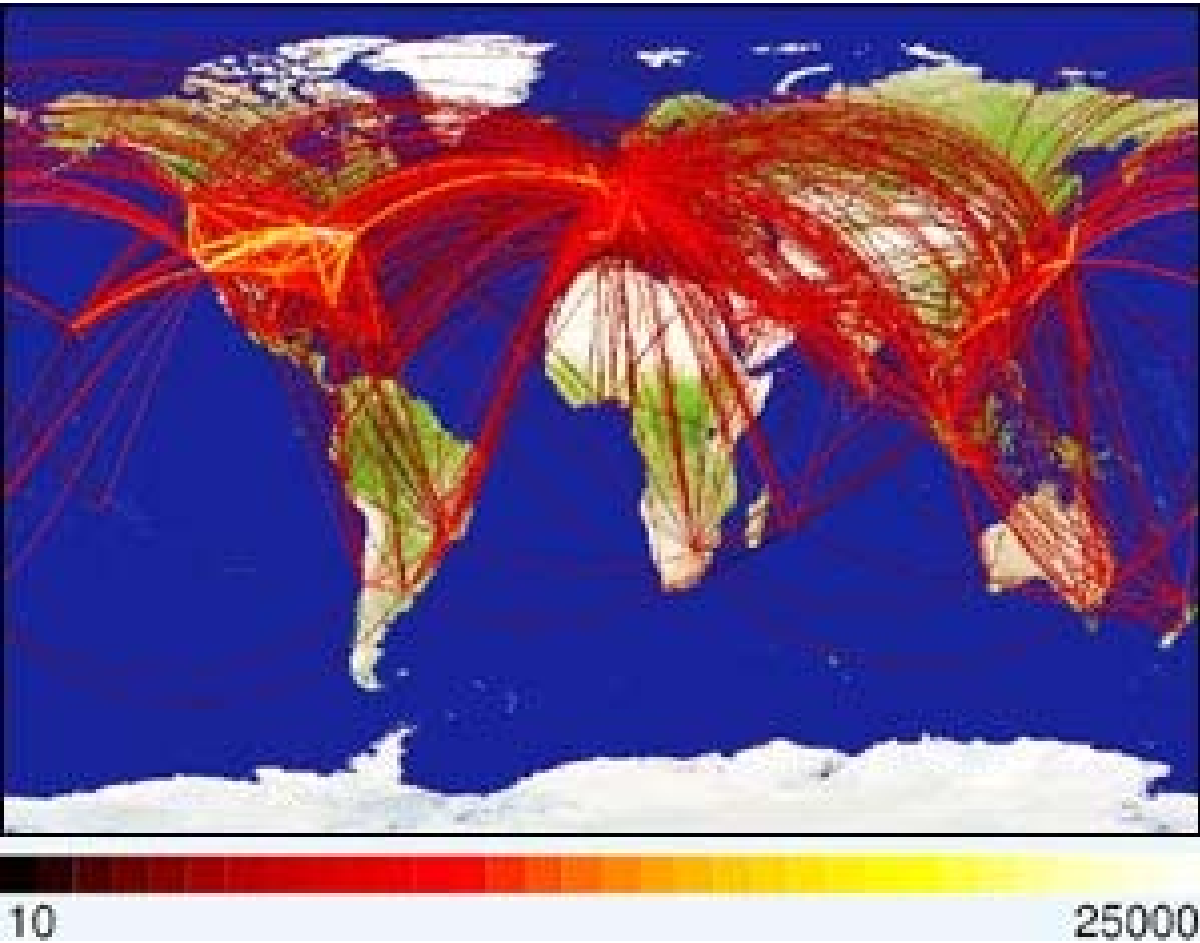
CO2 emissions



Emissions

	Car-free project	Reference settlement
Selected areas of consumption	in kg CO ₂ per capita	
Energy (heating, warm water, electricity)	489	620
Public transport	88	62
Holiday transport (mainly airtravel)	1,336	1,119
Car, motorbike, etc.	57	817
Food	292	163
Hotel and restaurant	212	128
Other	1,730	1,615
total	4,202	4,524

Approach allows linking the global and the local



Conclusions

- Holistic approach
 - Territorial, Production *and* Consumption
 - Territorial explains *where*
 - Consumption explains *why*
- Combination of top-down and bottom up
- Analyses at different scales: global, national and local

Conclusions cont...

- Scientific challenges
 - Uncertainty, data, methods, definitions, ...
 - Can be overcome with time
- Policy and Regulatory Challenges
 - Actors operate outside of their "territory"

Conclusions cont...

Currently, we see a separation between a country's consumption and the global production system

Rich countries tend to have:

- Stabilized production-based emissions
- Increased consumption-based emissions

Brings into question decoupling of economy and emissions

Conclusions cont...

- “Shadow Consumption based Indicator” alongside official accounting
- Effective policy on sustainable consumption and production
- Increase transparency and equity in climate change policy



Thank You

Klaus Hubacek

k.hubacek@leeds.ac.uk

+ Glen Peters, Chris Weber, Dabo Guan, Jan Minx

Selected References

- CP/RAC (Regional Activity Centre for Cleaner Production (2008). *A Consumption-based Approach to Greenhouse Gas Emissions in a Global Economy: A Pilot Experiment in the Mediterranean. Case Study: Spain.* Barcelona.
- Dabo Guan, Glen P. Peters, Christopher L. Weber, Klaus Hubacek (2009). "Journey to world top emitter - an analysis of the driving forces of China's recent CO₂ emissions surge." *Geophysical Research Letters*. 36, L04709.
- Guan, Dabo, Peters, Glen, Christopher L. Weber, and Klaus Hubacek (2008) "The Drivers of Chinese CO₂ Emissions from 1980 to 2030"; *Global Environmental Change*. Vol. 18. 626-634.
- Ornetzeder, M., Hertwich, E., Hubacek K., Korytarova, K., Haas, W. (2008). "The Environmental Effect of Car-free Housing: A Case in Vienna." *Ecological Economics*. Vol. 65/3, 516-530.
- Peters, Glen, Christopher L. Weber, Dabo Guan, Klaus Hubacek (2007) "China's growing CO₂ emissions - a race between lifestyle changes and efficiency gains". *Environmental Science and Technology* 41, pp.5939-5944.
- Peter, Glen P. And Edgar G. Hertwich (2008). *CO₂ Embodied in International Trade with Implications for Global Climate Policy.* *Environmental Science & Technology*, Vol. 42/5, 1401-1407.
- Weber Christopher L. and Scott H. Matthews (2008). Quantifying the global and distributional aspects of American household carbon footprint. *Ecological Economics*, 66, 379 - 391

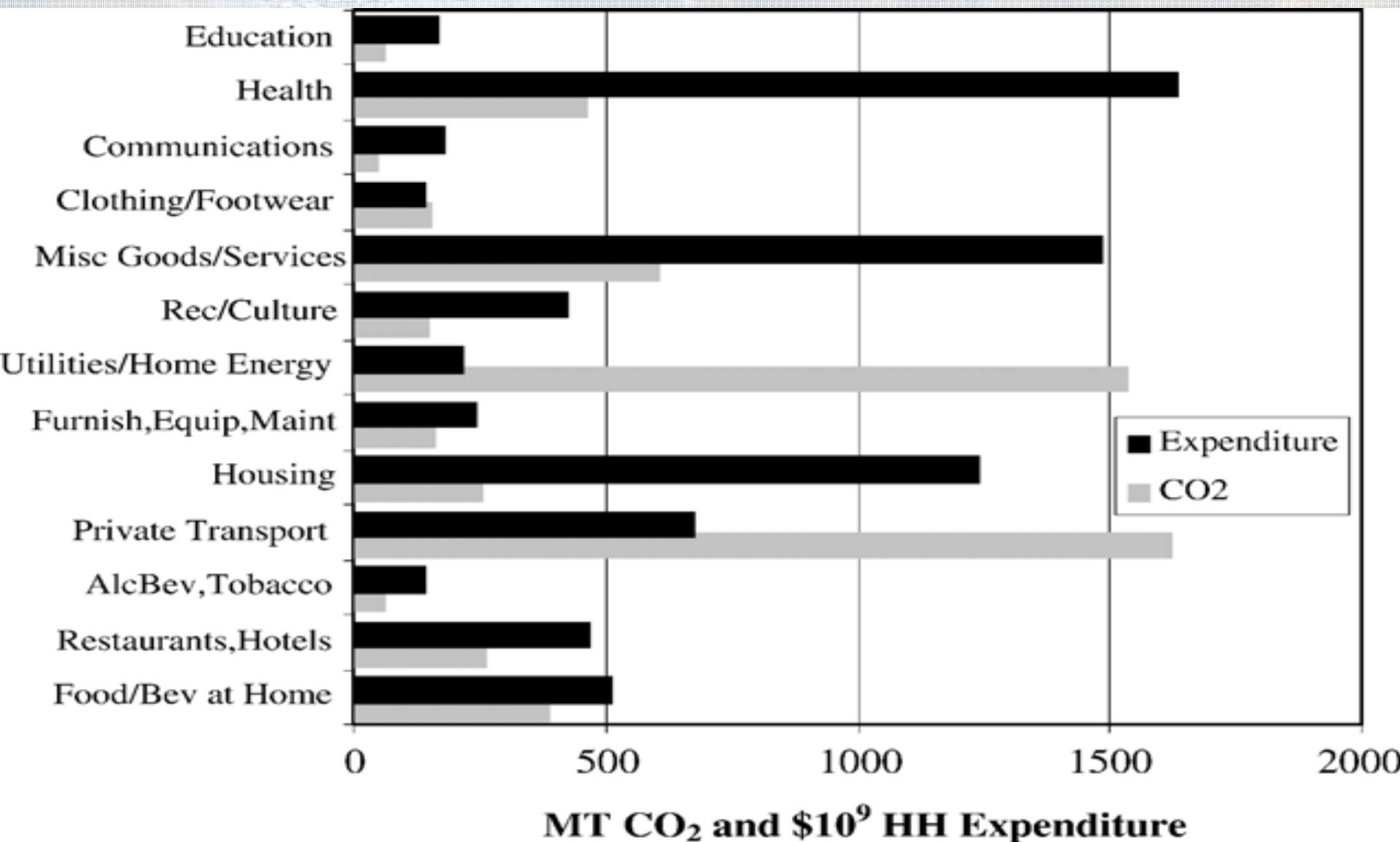
Additional slides



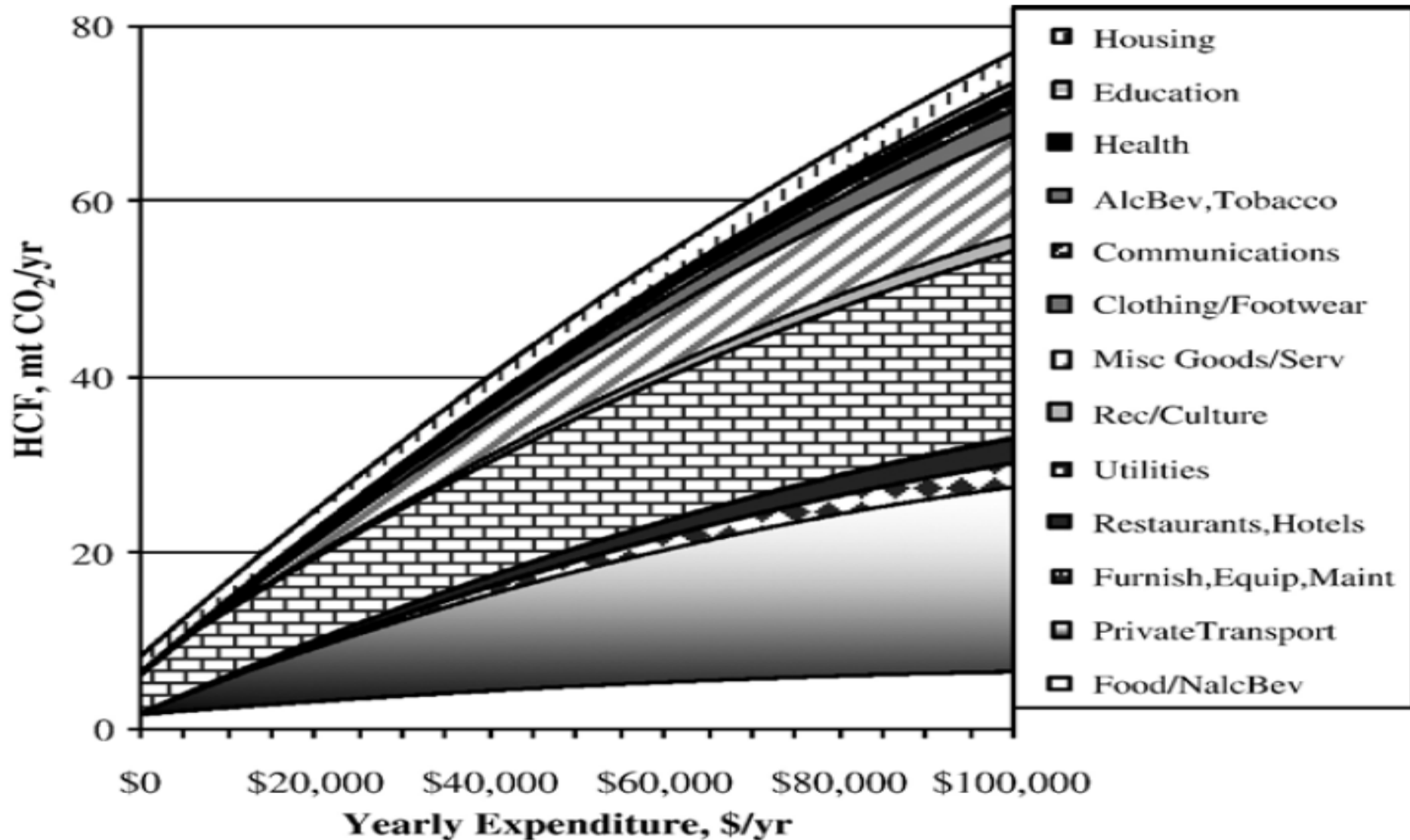
An aerial photograph of a multi-lane highway with heavy traffic. The image is overlaid with a grid of small white circles, each containing a number, representing carbon footprints. The text "Carbon Footprint for US Households" is overlaid in blue. The background shows a highway with many cars, some of which are also marked with the same white circles. The overall scene is a mix of urban infrastructure and natural landscape.

Carbon Footprint for US Households

Carbon Footprint for US Households (2004)

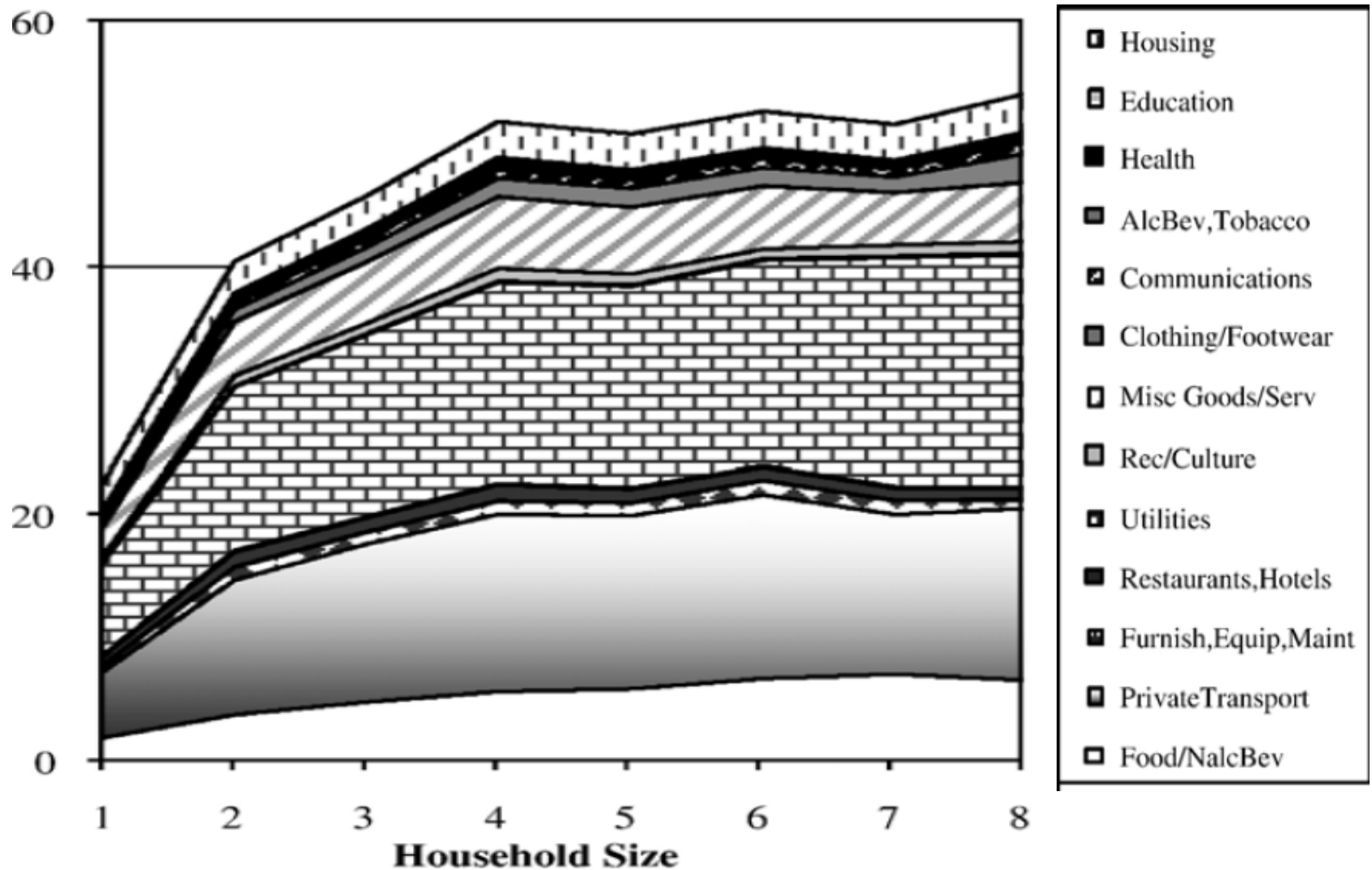


Carbon Footprint and Income



(Weber & Matthews, 2008)

Carbon Footprint and Household Size

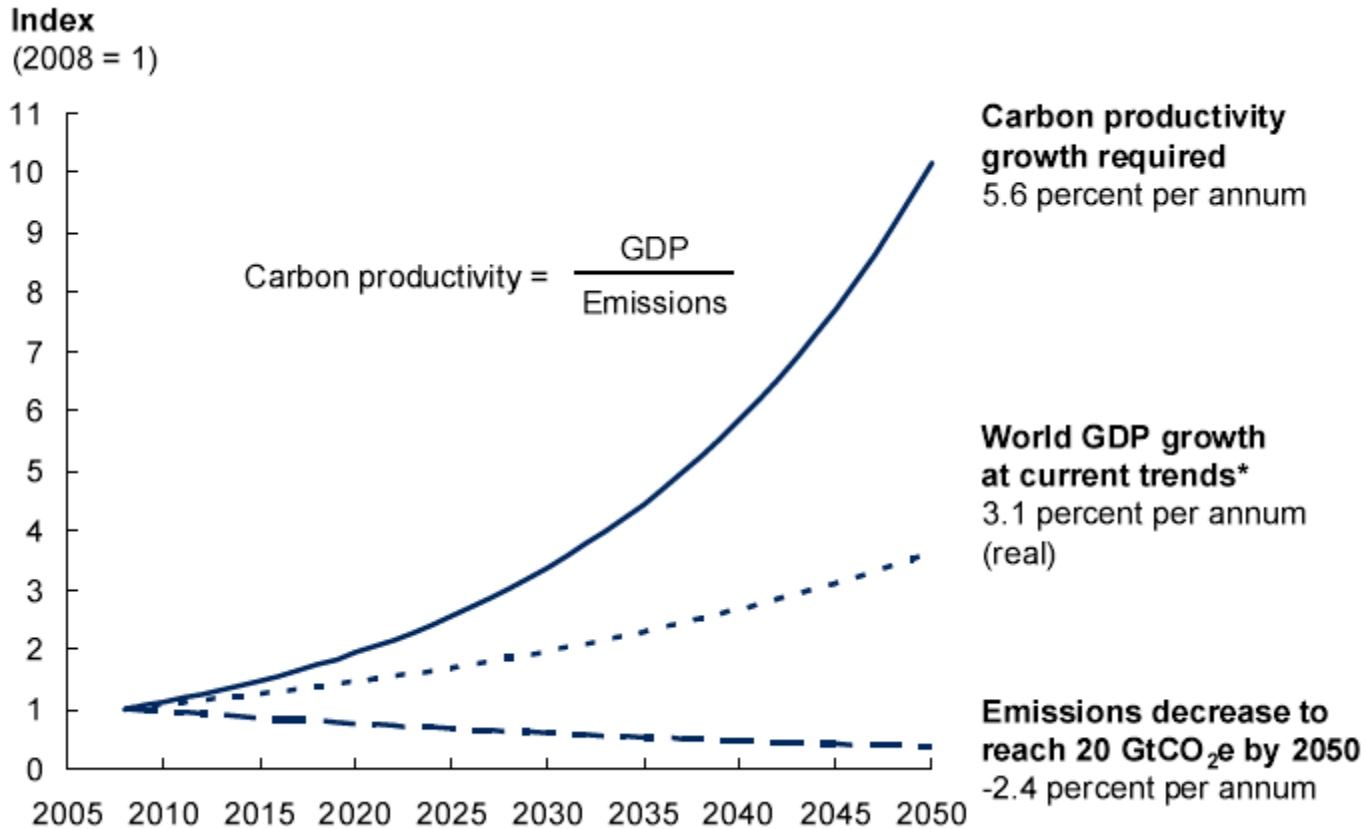


(Weber & Matthews, 2008)

US - Summary

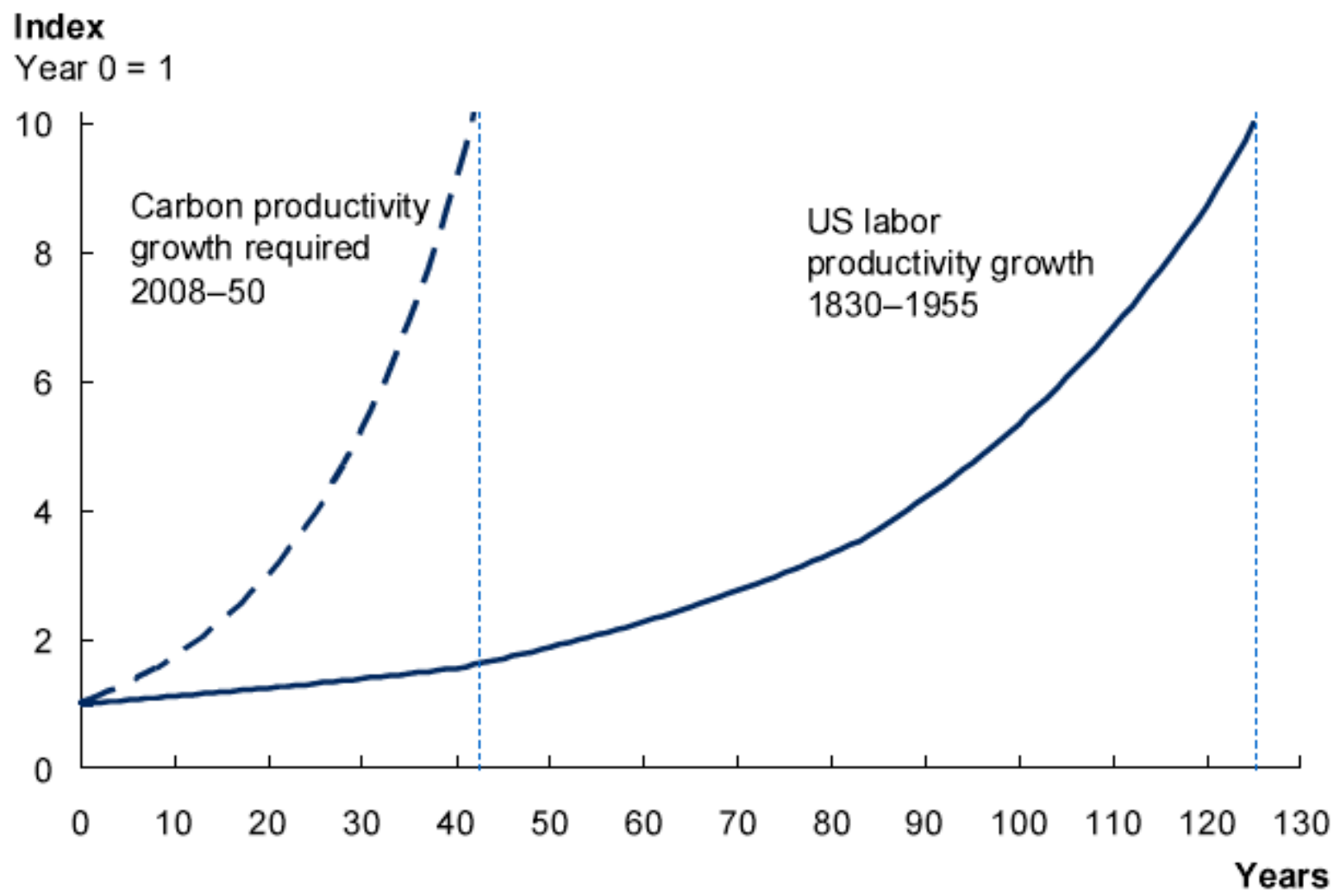
- Households vary considerably in their CO₂ responsibilities
- Household income and expenditure being the best predictors
- 30% of total US household CO₂ was produced outside the US

How to reach 20 GtCO₂e by 2050



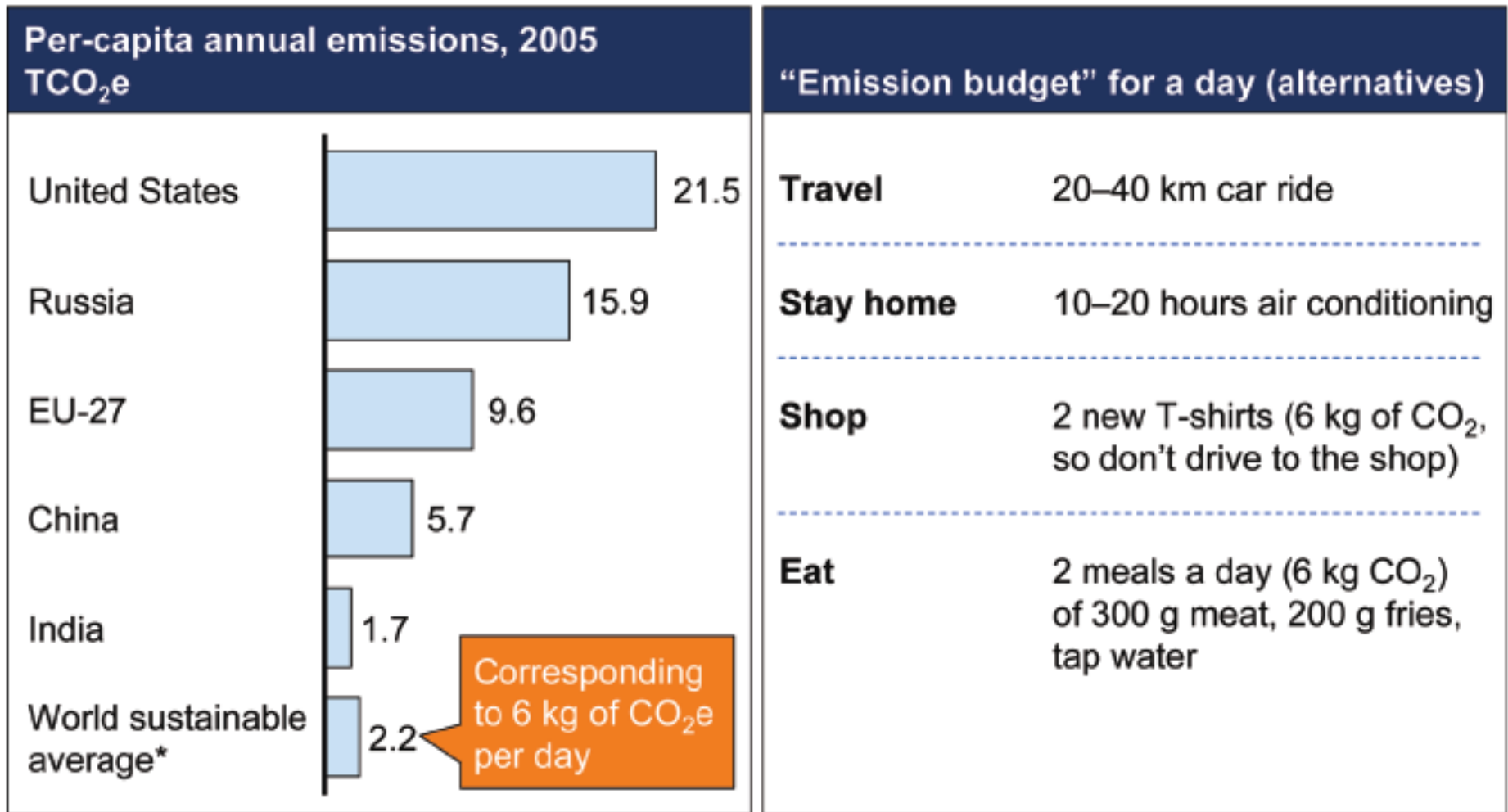
Source: McKinsey Analysis

A 'Carbon revolution' needs to be 10 times faster than the industrial revolution rise in labour productivity



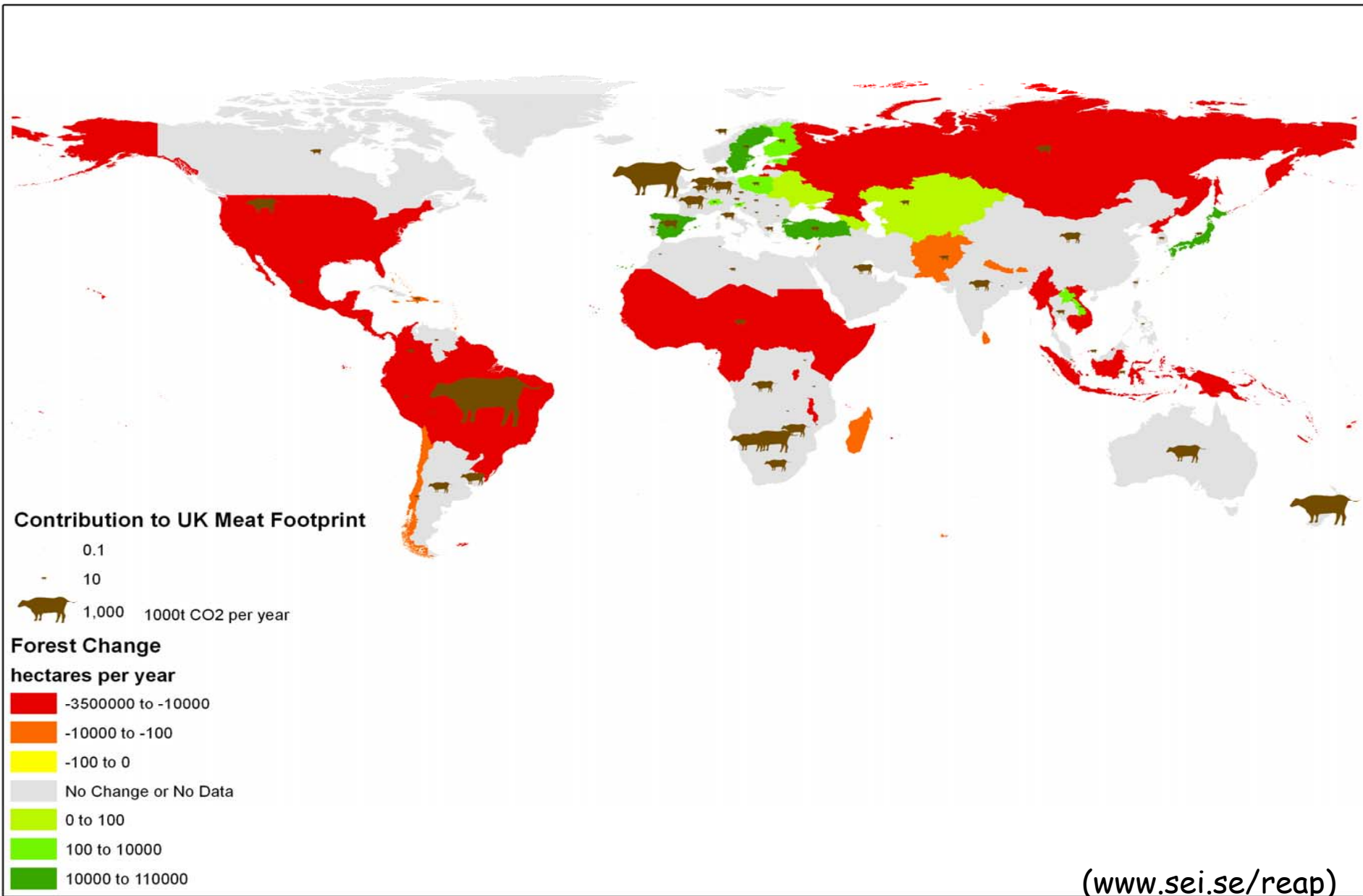
Source: Contours of the world economy 1-2030 A.D. Madison, 2007. McKinsey Analysis.

Live at 20 GTCO₂e per year

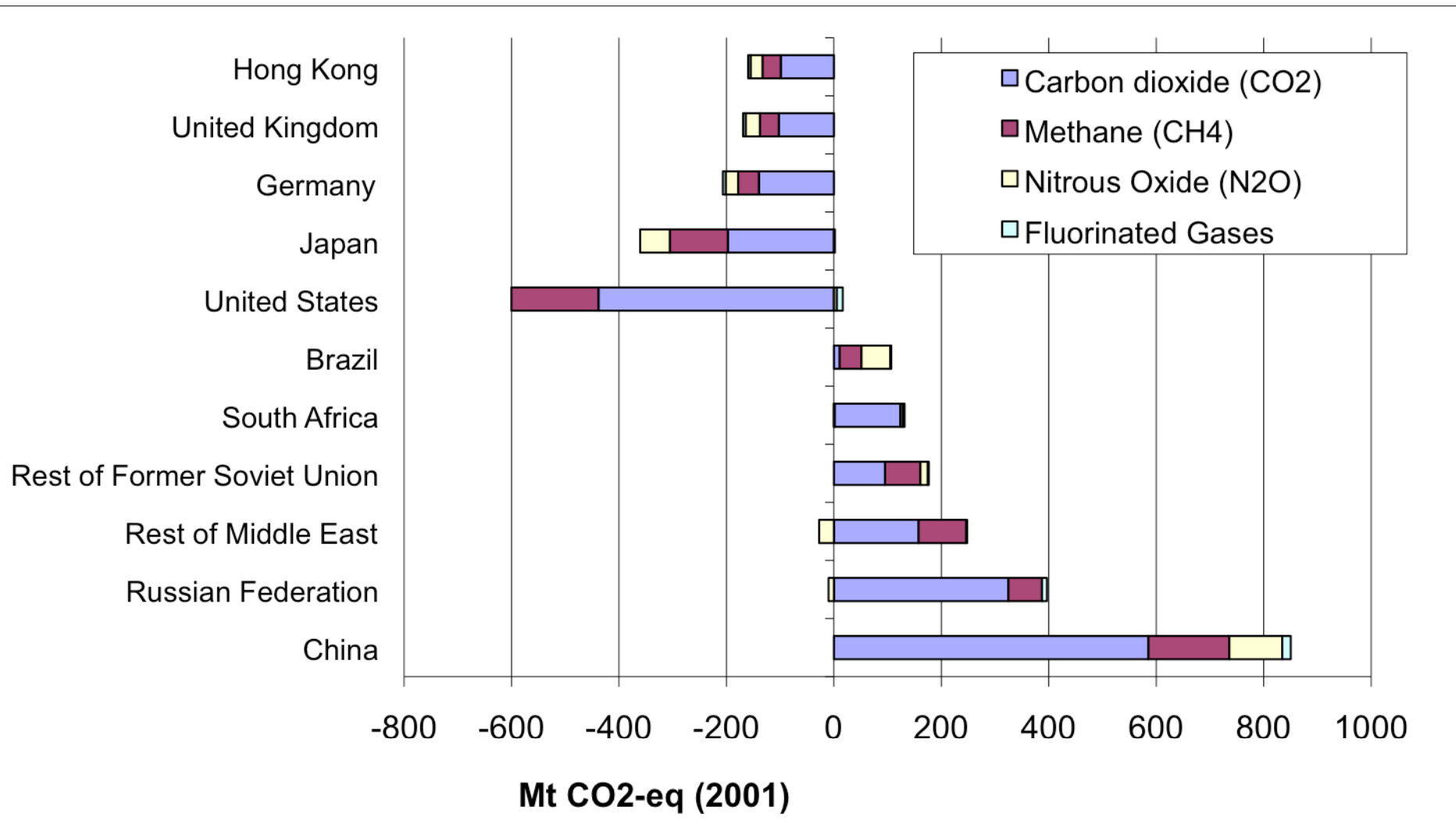


Source: McKinsey Analysis

Carbon emissions from meat consumption



Global Balance



IPCC definition: “national (including administered) territories and offshore areas over which the country has jurisdiction”

Production-based inventories are based on the economic activities of residential institutions as defined in the System of National Accounts (including international economic activities primarily, international transportation and tourism—as defined in GDP

Consumption-based emission inventory as the total global emissions occurring from economic consumption within a country

Approaches

- case-control study of the 'car-free' settlement
- combination of the quantitative and qualitative social research designs
 - with input-output analysis,
 - LCA,
 - questionnaires, and
 - qualitative interviews.

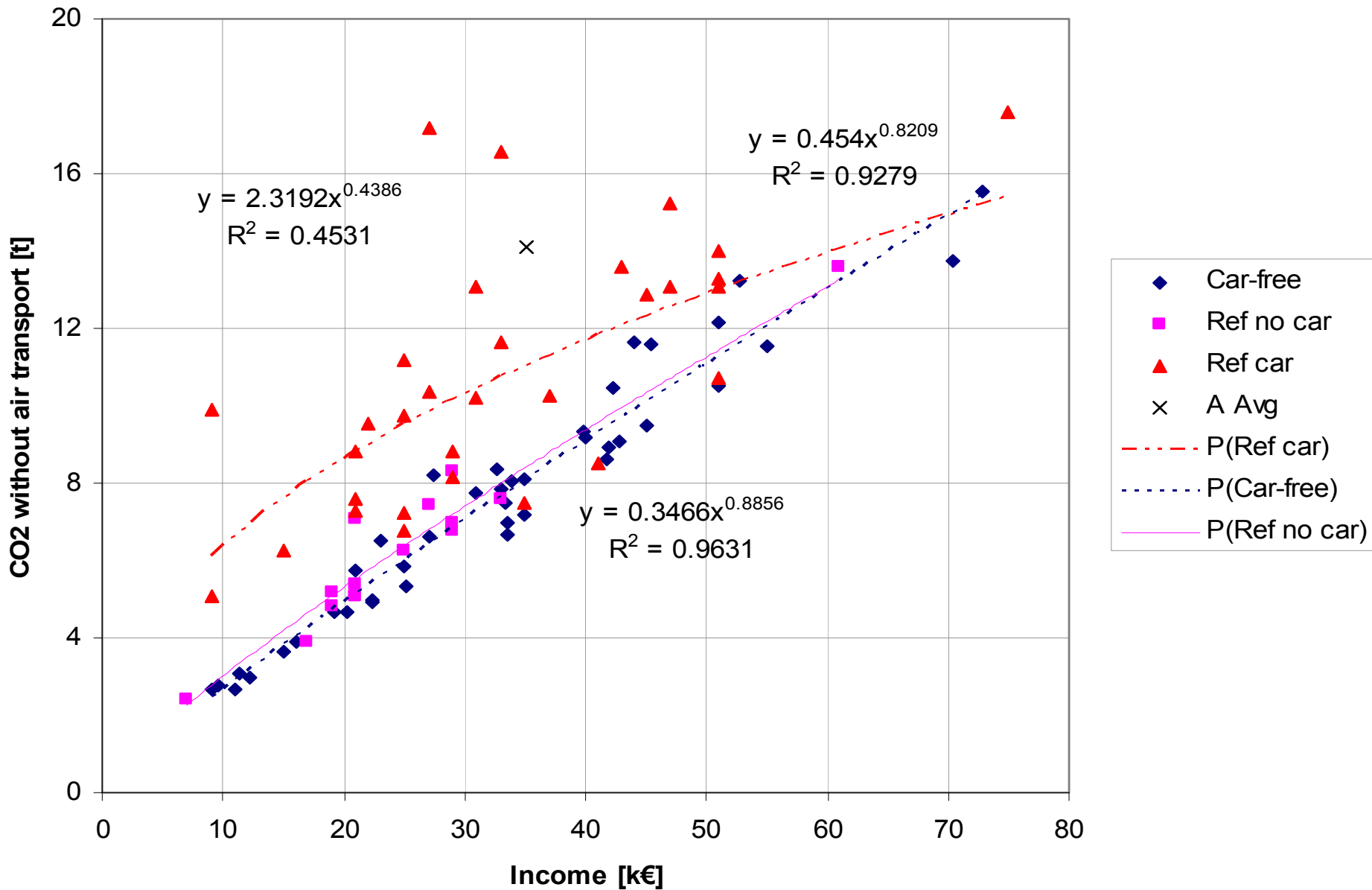
Emissions

	CO ₂ [t]	NO _x [kg]	COD [kg]	AO _x [g]	Toxic waste[kg]	Energy [GJ]	Expenditure [k€]
Car-free	4.2	14	10	15	61	75	12.7
Reference	4.5	13	9	13	54	80	11.2
Average	7.0	16	11	16	72	101	14.3

Mobility

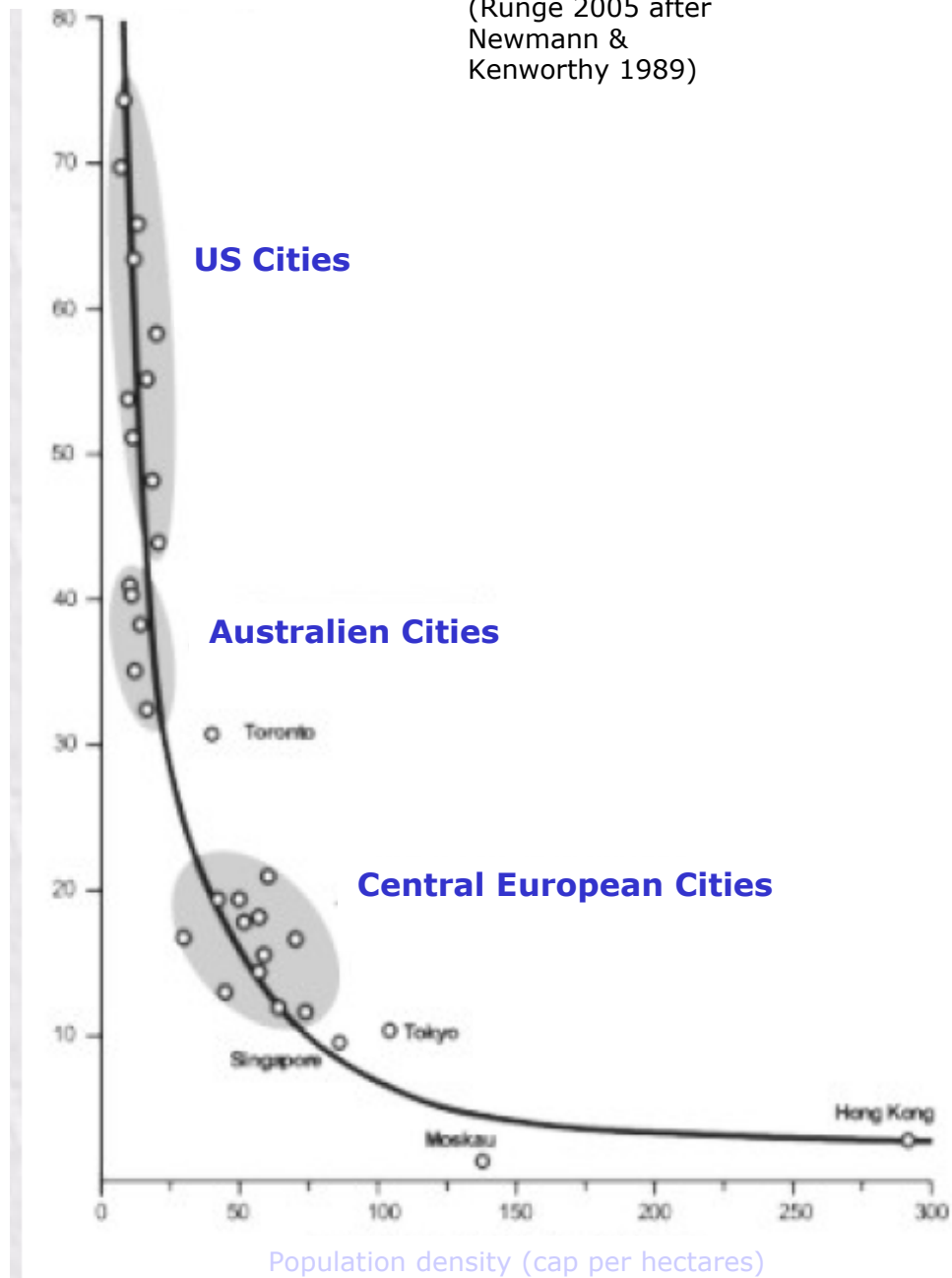
Selected types of transport	Car-free project	Reference settlement
by car		
households with 0 km in 2003	59.5%	27.3%
total (all households) in 2003 (km)	(42 hh) 23,778	(46 hh) 505,018
by car-sharing	8,778	4,240
average distance per household in 2003 (km)	566	10,979
by train		
total (all households) in 2003 (km)	77,600	5,700
average distance per household in 2003 (km)	1,848	124
by airplane		
share of households without flights in 2003	42.9%	52.2%
total (all households) in 2003 (km)	291,800	286,900
average distance per household in 2003 (km)	6,948	6,237
total distance by car, train, airplane per household (km)	9,362	17,340

CO2 emissions



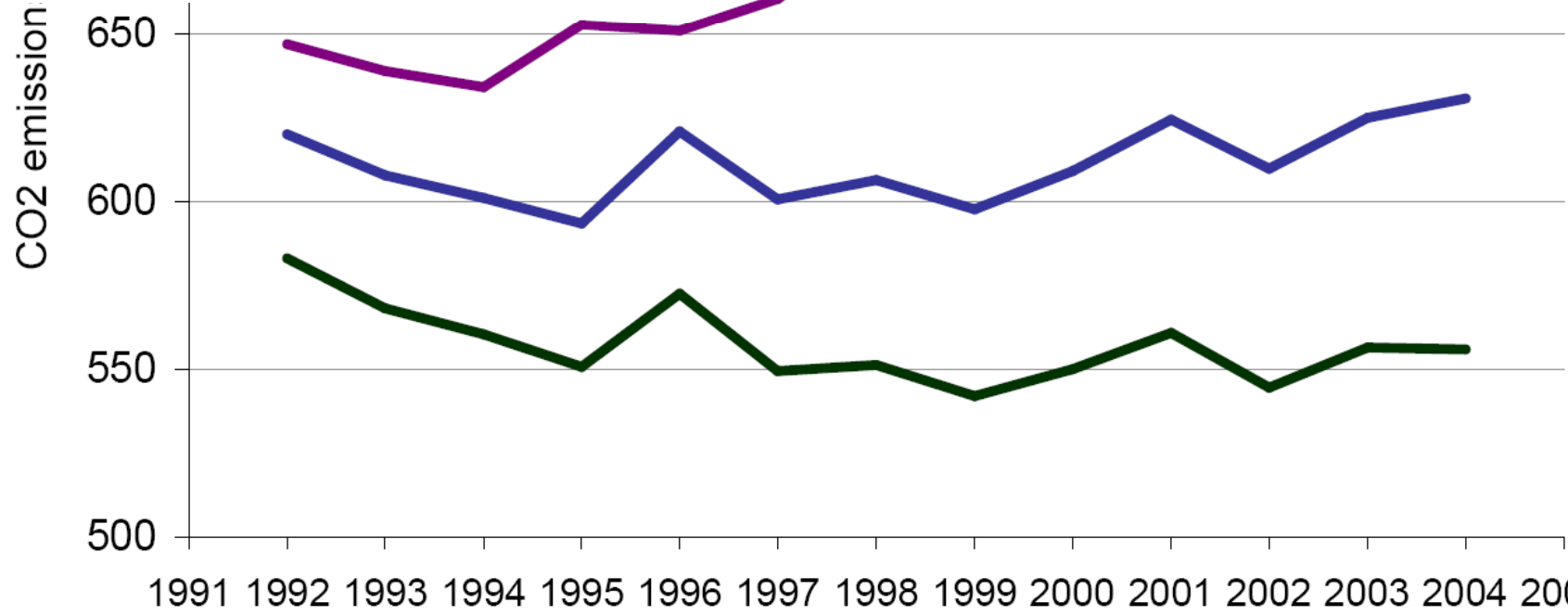
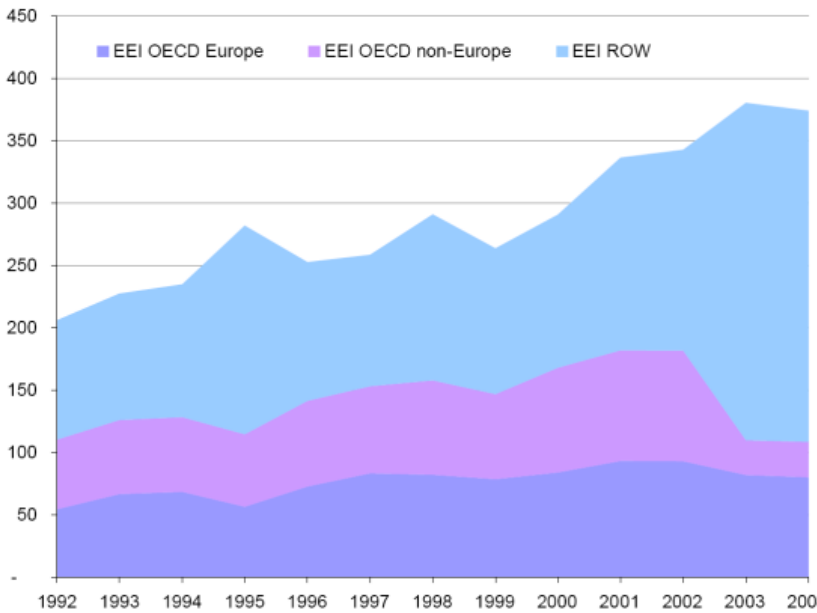
Fuel consumption in 1000
Megajoules per capita

(Runge 2005 after
Newmann &
Kenworthy 1989)



Population density (cap per hectares)

United Kingdom



Structural Decomposition Analysis (1981-02)

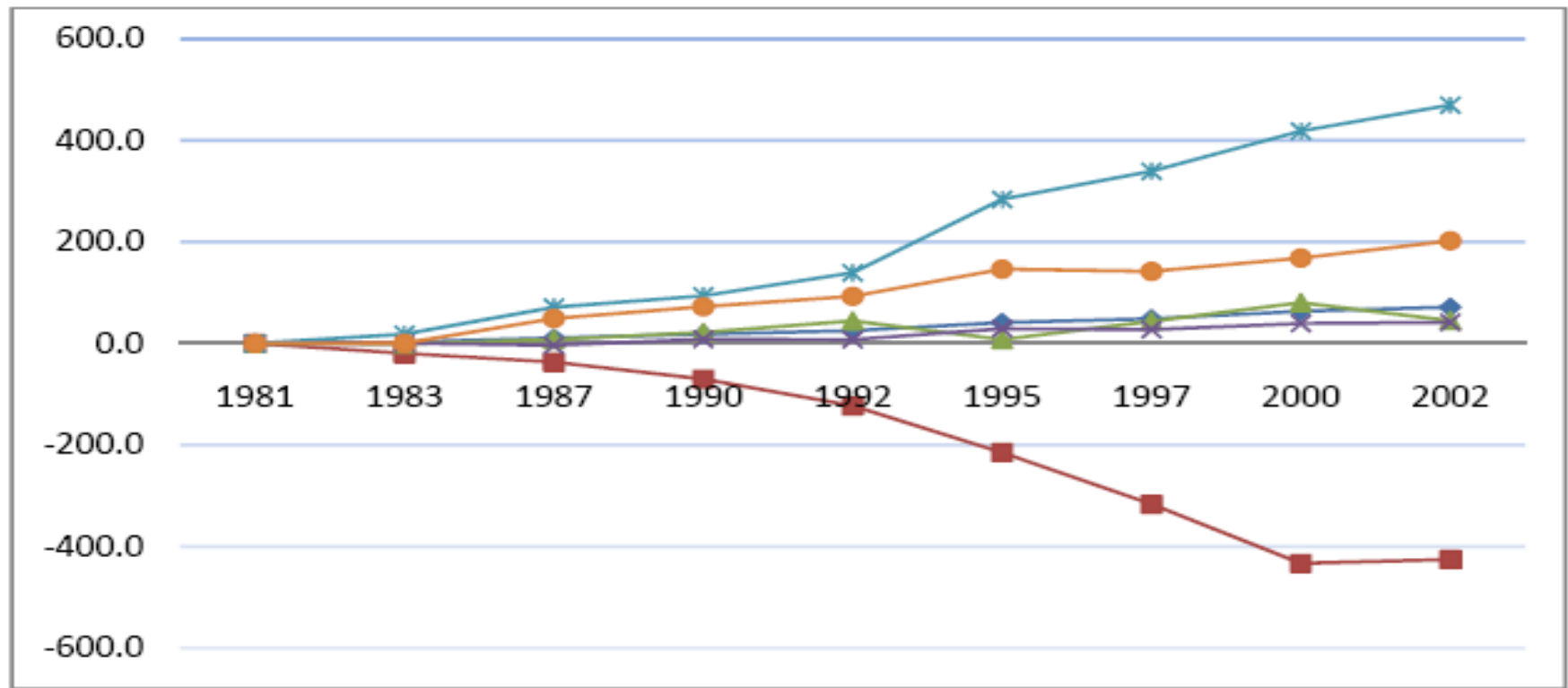


Figure 1: The orange line shows the percentage change in CO₂ emissions from 1981 to 2002. Other colored lines represent the contribution to change from GDP per capita growth (light blue, 469%), efficiency gains (red, -425%), population (dark blue, 72%), production structure (green, 45%), and consumption patterns (purple, 42%). The inconsistent efficiency gains (red line) between 2000 and 2002 are due to the under-reporting coal consumption at the end of 1990s (6, 20).

(Guan, et al. 2009)

